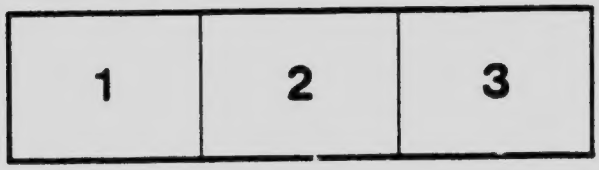

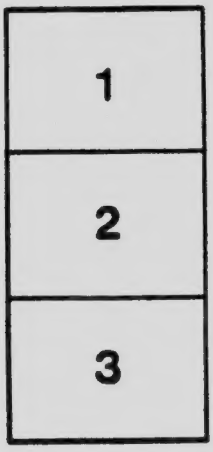

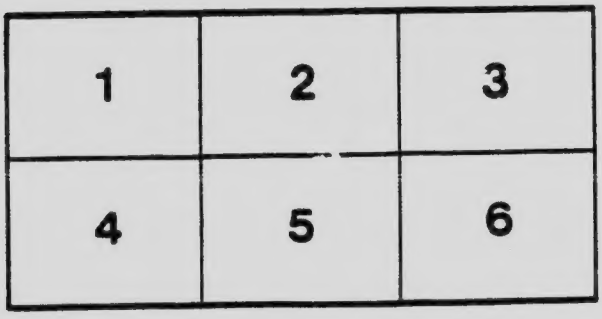

GEOLOGICAL REPORT

ON THE

CHIBOUGAMAU MINING REGION

IN THE

NORTHERN PART OF THE PROVINCE OF QUEBEC

A. P. LOW, B.S., F.R.G.S.

1906

OTTAWA
GOVERNMENT PRINTING BUREAU
1906

No. 923.

ROBERT BELL, LS.O., LL.D., M.D., D.Sc., etc.,

Acting Director,

Geological Survey of Canada.

SIR,—I herewith beg to submit my report on the Chibougamau Mining Region of the northern part of the province of Quebec, along with its accompanying map.

I have the honour to be,

sir,

Your obedient servant,

A. P. LOW.

OTTAWA, February 12, 1906.

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REPORT

ON THE

CHIBOUGAMAU MINING REGION.

By A. P. LOW, 1905.

The following report contains the result of a short season's work in the new mining region in the neighbourhood of Chibougamau lake, in the northern part of the province of Quebec.

Early in the year 1905 a request was made for my services by the Hon. Minister of Marine and Fisheries, to continue the Arctic exp[illegible]tion under the control of that Department. Late in the [illegible] a change of plans rendered my services unnecessary in this connexion; in the meantime a largely signed petition had been received from prominent citizens of Quebec addressed to the Rt. Hon. Sir Wilfrid Laurier, asking that a geologist be sent from the Geological Survey to examine the newly discovered mining region of Chibougamau lake. My services were detailed for this work and I left Ottawa on the 21st of June for Lake St. John.

Here four young Indians well acquainted with the region were engaged as canoemen for the summer and four others to assist in the transport as far as the field of work. Lake St. John was left o[illegible]the 25th, but owing to the exceedingly low water in the rivers, esp[illegible]ally in the Chigobich branch, the height-of-land was not passed until the 8th of July. The extra men were paid off here and sent home. We then passed through crooked Obatogamau lake and by small, almost dry, streams from that [illegible] to Chibougamau lake where we arrived on the 12th, and where [illegible]mall party of miners was found working on the asbestus outcrops on Asbestus island in the northwest part of the lake.

The journey was continued through a number of small lakes that form the portage route between Chibougamau and Wakonichi lakes. A log survey was made along the shore of the last named lake to its discharge into Mistassini lake and a visit was paid to the small post of the Hudson's Bay Company there. At the post a number of old

men, women and children were congregated awaiting the arrival of the big canoes with loads of flour and goods from Rupert House on James bay.

Returning from the post we followed the west side of the south-west bay of Mistassini back to Wakoniehi in search of the contact between the flat-lying limestone of the former lake and the disturbed rocks to the westward; in this we were unsuccessful. The west side of Wakoniehi lake was then surveyed back to the portage route to Chibougamau; this was again traversed and that lake was reached on the 22nd.

The following two weeks were spent in closely examining the rocks along the shores and on the numerous islands of Chibougamau, after which we passed into the adjoining Doré lake and followed its outlet, the Chibougamau branch of the Nottaway river, to its junction with the Obatogamau branch, which rises in the lake of that name. The junction of these streams was reached on the 18th of August, when the return journey was made by the Obatogamau branch, passing, for the greater part of the way, up a sluggish crooked stream to the lakes at its head, through a flat swampy country.

The study of the rocks and surveys along this branch and its lakes occupied us until the 28th, when we started on the return journey to Lake St. John and by shooting all the rapids along the river arrived there on the 1st of September, thus finishing a season most remarkable for its fine weather, not a day having been lost by rain or head winds.

The portion of country under consideration lies in the northern part of the province of Quebec, just beyond the southern watershed, so that it is drained by streams emptying into the Nottaway and Rupert rivers, both of which discharge into the southeastern part of James bay. It is situated between 73° 40′ and 75° 30′ West Longitude; and extends northward from 49° 30′ to 50° 30′ North Latitude; consequently it is roughly about eighty miles from east to west, and about seventy miles from north to south.

The southern boundary of the area is about 280 miles north of Ottawa city, and lies directly north of the country between Montreal and Ottawa.

Being situated beyond the height-of-land dividing the southern waters from those flowing west, it can only be reached from the south by ascending to its head one of the several tributaries of the St. Lawrence that drain the country south of the area; of these the Gatineau, St. Maurice and the Chamuchuan are the largest and the most easily navigated. The shortest route from civilization is by way of the last-named river, which flows into Lake St. John. Its mouth is easily reached by the Quebec and Lake St. John railway; and from there the distance by canoes is [illegible] 150 miles to the south end of Obatogamau lake, just inside the southern boundary of the area.

The routes by the St. Maurice river lead to Obatogamau or the headwaters of some of the western branches of the Nottaway. The railway is available to Grandes Piles, where small river steamers may be taken to La Toque, to which place a branch of the Lake St. John railway is now building. From La Toque the distance by canoes to Obatogamau is about the same as from Lake St. John, while the route is more difficult. By the Gatineau route, the railway may be taken from Ottawa to Maniwaki, and from there a long and difficult canoe journey to the headwaters of the river passes either into the upper parts of the St. Maurice, and so to Obatogamau, or else across the watershed to one of the western branches of the Nottaway, which must be descended to Waswanipi whence the Chibougamau branch must be ascended either to that lake or to Obatogamau; both routes are long and difficult, and, together with that by the St. Maurice, do not compare favourably with the route from Lake St. John. With the construction of the Grand Trunk Pacific railway, a shorter and better route will probably be found from the upper waters of the St. Maurice, but, in the meantime, prospectors going to the Chibougamau region will be wise to confine themselves to the Lake St. John route, unless they wish to prospect along the other routes.

Previous Explorations and Journeys in the Region.

The earliest mention of the region about, and to the north of, Lake St. John occurs in the Relations of the Jesuits; there we find that in 1641, the missionary, Jean de Quen, ascended the Saguenay and discovered Lake St. John. A few years later a permanent mission was established among the numerous Indians frequenting the lake-shores during the summer season. After a few years, smallpox and the wars with the Iroquois practically exterminated the natives of the region and the mission was abandoned.

In 1661, the missionary, Dablon, was sent, by the Governor of Canada, to Hudson bay, by way of Lake St. John and the Rupert river. He appears only to have reached Nikabau lake being unable to go farther owing to the Iroquois war-parties in the country to the northwest.

The Hudson's Bay Company, having established their first post at the mouth of the Rupert river, in 1669, the French authorities in Canada despatched the missionary, Charles Albanel, from Quebec to observe the doings of the English on Hudson bay, and to induce the Indians to continue bringing their furs south to Quebec. He made the journey by way of Lake St. John, and passed the winter in the vicinity of Nikabau lake. The following year he crossed the watershed, and passing through Lake Mistassini, descended the Rupert river to James bay.

An ordinance respecting the King's Domain, issued at Quebec in 1733, mentions, among others, the trading posts at Lake St. John, Nikabau, and 'Mistassinoc,' which shows that the French fur-traders were at that early date acquainted with the region under discussion; and in 1732, a survey had been made from Lake St. John to Nikabau by Joseph Normandin.

Shortly after the conquest of Canada, the Northwest Company was established, and soon acquired the lease of the King's posts. Traces of their old post at Mistassini are still visible in the southern bay of the lake. Although long well known to the fur-traders, no attempt was made by the Government to explore the region, from the time of the visit of the celebrated French botanist, André Michaux, to Mistassini, in 1782, until 1860 when A. F. Blaiklock surveyed the Mistassini and Chamuchuan rivers from their mouths for more than a hundred miles up.

The first exploration of the Geological Survey in this region was made in 1870, by James Richardson, who ascended the Chamuchuan river from Lake St. John to the height-of-land and passing through Obatogamau, Chibougamau and Wakonichi lakes, surveyed the southern part of Mistassini lake. The following year, Walter McOuatt ascended the Mistassini river from Lake St. John to near its head, where he crossed to the headwaters of the Chêf branch of the Chamuchuan, and from there over the watershed into Mistassini lake, where he continued the survey of Richardson, but failed to reach the north end of the lake. Richardson, in his report, called attention to the dark irrupted rocks along the shores of the lakes to the southwest of Mistassini, and noted the presence of iron, copper and serpentine in several localities.

Nothing farther was done towards the exploration of this region until 1884, when a joint expedition from the Geological Survey and the Quebec Crown Lands department, was sent north to complete the survey of Mistassini lake. This expedition was under the charge of John Bignell, P.L.S., and the writer was attached to it as geologist. The main party reached Mistassini late in the year, having followed the route of the Bersimis and Peribonka rivers to the height-of-land. In the following February the writer made a trip to Lake St. John; returning in April, he passed over the route explored by Richardson, but being very short of provisions did not extend that scientist's observations in the mineral-bearing area southwest of Mistassini. In 1892, while journeying to the Eastmain river, the writer again passed hurriedly over this route, and little was accomplished beyond confirming the statements of Richardson.

Mr. Brock, acting as assistant to Dr. Bell, in 1896, ascended the Chibougamau branch of the Nottaway, from Waswanipi lake, and marked the geological formations between there and Wakonichi.

In 1897, Mr. M. H. O'Sullivan in his reports on the country between Lake St. John and James bay, draws attention to the previous

work of the Geological Survey, and describes the country in the basin of the Nottaway.

Accurate surveys of the lakes and river stretches under consideration were completed by Mr. C. E. LeMoine, P.L.S., for the Quebec government in 1899.

Mr. Peter McKenzie, having read the published reports on the region, determined to make a prospecting and trading journey through it in 1903. While looking for iron ores in the vicinity of the eastern end of Chibougamau, he chanced upon an important discovery of asbestus there; he also prospected the copper-bearing rocks of Paint mountain, on that lake. The following year, accompanied by Mr. J. Obalski, Inspector of mines for the province of Quebec, he again returned to the region and continued his prospecting about Chibougamau lake. The area of the asbestus rocks was extended, and while searching for copper deposits at Paint mountain, a large mass of gold-bearing quartz was found. Small deposits of iron ores were also discovered.

On the return of the party, Mr. Obalski wrote a report which was published by the Quebec government* upon these discoveries.

Route from Lake St. John to Lake Chibougamau.

The Quebec and Lake St. John railway ends at Roberval, on the west shore of that lake, a few miles from the mouth of the Chamuchuan river. From Roberval, canoes and provisions should be transported by carts to the head of the Bear portage, in order to avoid some twenty-five miles of shallow and rapid river entailing four portages. The road from Roberval passes through the villages of St. Prime and St. Felicien on the west side of the river. About three miles above St. Felicien the road crosses the river by a fine bridge built between the islands of one of the heavy rapids; it then follows the east shore, rising over sandy terraces for six or seven miles, on the way to the large settlements along the Mistassini river. Leaving the main road, a sandy track leads in a mile to the high banks of the river immediately above the Bear portage.

The banks are upwards of a hundred feet high and, formed of clay overlain by sand, are continually being cut by the river, so that small land slides are frequent.

From the foot of the hill a mile and a half of quiet water leads to the Little Bear portage, which is 300 yards long and skirts a fall of 25 feet. In the next two miles the river is broken by heavy rapids, over reefs of rock; two long portages along the right bank are necessary to pass these obstructions. At the head of the rapids the river is nearly on a level with the surrounding country, and is broken for the next mile by small rapids. It then widens to 400 yards and, from the thirty-fourth mile, or for seven miles above,

* Mining operations in the province of Quebec 1904. J. Obalski

flows with a strong even current in a shallow sandy channel. Five large islands occur along this stretch; they are low, sandy and well-wooded with swamp-ash, elm, balsam-poplar and willows. The banks, at first low, rise gradually as the other end is approached, until, at a sharp bend to the west, the east side presents cut banks of sand that rise a hundred feet and more above the river.

After a western course of a mile, the river again turns north, and a series of heavy rapids begin, the lowest of which is called the Pimonka. The Laurentian highlands, which come within a mile of the west side of Lake St. John, continue northward some miles from the river and do not cross its course until this rapid is reached. The cut banks of clay and sand now give place to solid rock that rises from 150 to 300 feet above the water. The river becomes contracted and very rapid so that in the next twenty-two miles the rise is 341 feet, this rise including that at the Chaudiere falls, where the difference in elevation is 120 feet in less than a mile. The Pimonka rapid is three-quarters of a mile long, and is followed in the next mile by two short ones, then comes the Deep Bottom rapid between the 39th and 40th miles, where, at high water, the depth along the shore is too deep for poling, while the steep rocky banks will not allow of tracking. From the head of this rapid to the 44th mile the current is broken by only one short rapid, whence, to the Chaudiere fall, the river descends in a succession of rapids connected by short stretches of swift water, so that for twelve miles poles only are used in ascending with canoes.

At the Chaudière, the river passes over three distinct falls by tremendous rapids, the lowest fall having a sheer drop of sixty feet. The portage rises sharply 200 feet to the summit of a sandy ridge, which it follows for nearly a mile, and ends on the rocky shore a short distance above the upper fall. Within a half mile of its end another portage of 400 yards begins and leads past a low chute and rapid impassable with canoes.

A short distance above this portage the river leaves the narrow rocky gorge and the valley widens out to more than a mile across, while the walls become more rounded and are partly covered with soil, bearing a thick second-growth of aspen, birch, banksian pine and spruce.

The junction of the Chigobich branch is about a mile above the upper portage, the smaller river joining from the westward. This stream is commonly used by the Indians to reach A-huapmuchuan lake, the distance being considerably lessened by this route, which forms the hypothenuse of a right-angled triangle, the other sides being formed by the course of the main river. Both routes are bad, being broken by many strong rapids, past which long portages are necessary. At low stages of the river, the Chigobich is almost dry, and in many places can only be ascended with partly loaded canoes. There are several portages to pass in ascending the main Chamuchuan

to its forks, or along the north side of the triangle, while above, where it comes from the west, it is almost a continuous rapid for upwards of half of the distance to Ashuapmuchuan lake.

The Chigobich at its mouth is quite shallow and rapid, and at low water a long portage of part of the load is necessary to reach the deeper water above where the river varies from fifty to a hundred yards in width. In the first ten miles eight portages occur where the river is broken by heavy rapids and chutes. The surrounding country is rolling and somewhat rocky, covered with small second-growth.

The next stretch of ten miles is through a wide swampy valley where a sluggish current is broken in a few places by short rapids. In this distance a number of small tributaries enter, chiefly from the southwest, where they drain numerous lakes on the eastern slope of the Partridge mountains, a ridge of low hills running north and south, and crossing the river close to its outlet from Chigobich lake.

The river, now become very small, traverses a narrow valley between hills that rise from 100 to 300 feet above the water; being obstructed by large boulders in an almost continuous rapid it is very difficult to ascend for the final two miles to the lake.

Chigobich lake runs northward for fourteen miles, when it bends to the east and continues in that direction for some twenty miles. The southern arm has a general width of about a mile; it is very deep and is broken only by three small rocky islands that rise from its clear brown waters. The lake is surrounded by rounded hills, highest on the east side where they culminate in Chigobich mountain, a rounded hill rising boldly from the lake to an elevation of 420 feet, and forming a conspicuous landmark. The other hills on the east do not exceed 350 feet, while those to the west are less than 200 feet in elevation above the lake. There are considerable areas of unburnt forest about the lake, usually medium-sized black spruce.

From the angle between the two arms of the lake, a portage of a mile and a half passes westward over a dry sandy plain and ends at a small sluggish stream, which flows in a very tortuous course through a wide swamp. After passing two small lakes, it finally flows into the southeast end of Ashuapmuchuan lake, distant from the portage two miles and a half in a straight line, but over seven miles by the crooked course of the river.

Lake Ashuapmuchuan is some six miles long with an average breadth of one mile; its shore-line is broken by a number of rocky points and shallow bays, while the surrounding country is low and flat, with a few rocky ridges never more than 100 feet above the lake. The surrounding country appears to be fertile, as, in the clearing about the old Hudson's Bay Company post, timothy grass grows abundantly, and small fruits ripen early.

The Chamuchuan river which, above the lake, is known as the Nikabau river, flows into the northwest part of the lake, and flows

our again within a mile of the inlet. For several miles above the lake, to the Pole rapid, the Nikabau meanders through a low country broken only by a few rocky hills. The Pole rapid is upwards of a mile in length and is only passable by half-loaded canoes, the remainder of the load being carried over a long swampy portage. Immediately above, another portage, somewhat shorter, passes a heavy rapid where canoes cannot be used at all.

Little Nikabau lake is twelve miles above this portage; in this distance are a number of short heavy rapids but with only one entailing a portage in ascending the stream. The lake is a mile long and is connected with Nikabau lake by a couple of lake expansions extending over a distance of three miles.

The larger lake is four miles long, and varies from four to twelve furlongs in breadth. It is surrounded by low and swampy country, covered with a growth of medium-sized, black and white spruce, fir, banksian pine, aspen and balsam poplar, white birch and cedar. Two streams enter the lake: the western one, the larger, leads through several lakes to the headwaters of the St. Maurice; the smaller, which comes from the north and is used to reach the height-of-land, some twenty-four miles above the lake, connects a chain of six small lakes by short, sharp rapids.

There are two portages into Whitefish lake, where the main stream is left, one leading from the river into the south end of the lake, the other following the branch stream which drains the lake, and leaves it at its northeast corner. Another portage leads from Whitefish lake through a deep swamp nearly a mile across to a smaller lake, having a conspicuous hill on its west side. From there the height-of-land is crossed by another portage of nearly a mile ending in a small lake, whose outlet is followed northward for about five miles until it discharges into the southeast bay of Obatogamau lake. The stream falls nearly 150 feet in the descent to the lake, and has five portages past as many shallow rapids.

The general direction of the route from Lake St. John to the height-of-land is nearly northwest and the distance is about 150 miles. Travelling with only average loads in good cedar canoes, with the water in the streams at a moderate height, and with a crew of the best men belonging to Lake St. John, it took us ten days to reach the shores of Obatogamau. This journey was divided as follows:—Two days and a half, from Bear portage to the mouth of the Chigobich; three days and a half to Ashuapmuchuan lake; and four days to Obatogamau.

General Description of the Region.

Situated as it is, immediately north of the height-of-land dividing the waters of the St. Lawrence from those of Hudson bay, the region under consideration has the flatness characteristic of all the

central interior of the Labrador peninsula. Taken as a whole, the area may be described as a rolling tableland, the general elevation of 1,400 feet above sea-level near the water-shed falling gently to less than 900 feet in the northwest.

The general surface is everywhere broken by long low ridges of rocky hills which, in few places, have an elevation of more than fifty feet above the surrounding water levels, and whose general trend is from east-northeast to west-southwest. Where the ridges are close together the intervening valleys contain swamps drained by small brooks, but, more often, the ridges are wide apart and the shallow valleys are covered with networks of lakes fringed with wide areas of swampy land. In the southern and eastern portions, many of the lakes are large and often have long irregular bays that adopt the general trend of the ridges. Many of these lakes are so indented and dotted with islands that it is difficult for even the Indian guides to follow correctly the channels.

A striking feature of the scenery are the isolated hills that cross the country in the same direction as the lower ridges in two broken chains. These hills rise from 300 feet to 600 feet above the general level of the country, and have a sharper conical outline than the lower hills of the region. The most important chain is that which crosses at the north end of Chibougamau and Doré lakes, where they are massed together to form a ridge of rough country from five to ten miles wide. Between the lakes and the height-of-land the ridge soon dies away in a few isolated hills. To the westward they skirt the north side of Doré lake and thence continuing westward, cross the Chibougamau river at the north end of Asinitchibastat lake and again on the north side of Opemiska and Mikwasach lakes, after which they appear to continue westward with lower altitudes beyond the limit of the map.

The second ridge lies a few miles to the north of the other and is only a line of unconnected conical hills extending from the north end of Wakonichi lake to and beyond the big bend of the Chibougamau river. The country along the course of this line is somewhat more broken than in other parts, but the hills are separated from one another by considerable stretches of comparatively level country. These hills are formed of granite and are more regular in outline and less abrupt than those of the southern ridge composed of basic rocks.

The line of the watershed runs diagonally across the southeastern corner of the map. The land to the south of the height-of-land, being somewhat higher than that of the Hudson bay side, there is a quick descent of 200 to 300 feet in passing from the divide northward, represented by an escarpment of that height following within a short distance the course of the line of the watershed.

The country in the southeast portion of the map, being situated on the south side of the watershed is drained by small branches of the Chamuchuan river; these are tributaries of the Nikaban branch

in the southern part and of the Chêf branch in the northern part of the area, and drain chains of small lakes such as are found throughout the north in the regions underlain by Archæan rocks.

At least three-fourths of the region under discussion is drained by tributaries of the Obatogamau and Chibougamau rivers which, at their junction, form the Waswanipi branch of the Nottaway river that flows into Rupert bay, a southeastern extension of James bay. A narrow band along the northern portion of the map is drained by small unexplored branches of the Broadback river—a large stream entering Rupert bay between the mouths of the Nottaway and Rupert rivers. All the above streams flow to the westward, but in the northeast portion of the map the drainage is towards the northeast into Mistassini lake, which in turn empties into the Rupert river; this stream, after a long detour to the north and east, finally changes its course to the westward and enters the sea a few miles to the north of the mouths of Broadback and Nottaway rivers.

None of the streams within the area of the map are large, but all of them are navigable with canoes to within a short distance of their source; this being the only practicable manner of travel through the country during the summer. The streams usually take their rise in chains of small lakes which partly fill the wide valleys between the low ridges of hills already described as traversing the country from east to west. As the ridges seldom continue unbroken for more than a few miles there are frequent opportunities of passing between them either by lakes or water courses, so that, with a knowledge of the country, canoe voyages may be undertaken in almost any direction, without portages much over—and usually a good deal less than—a mile in length.

Immediately on the northwest side of the watershed are situated a number of large lakes, extending in a northeast direction for many miles. Those included in the present map are, passing northward: Obatogamau, Chibougamau, Wakonichi and the southern bays of Mistassini.

The lakes along the main watercourses have been surveyed, and each small tributary is known to drain a similar system of lakes and swamps; practically, therefore, nearly one-third of the surface is occupied with water; if the swamps be included with the lakes, over one-half of the remaining surface may be considered as under water.

The surface of the ridges are, as a rule, formed of solid rock or boulders with little soil between them. Boulder clay is found everywhere except in some of the valleys where its constituents have been re-arranged by the action of streams into bedded sands and clays, which, being mixed with varying amounts of vegetable mould, constitute loams capable of supporting a strong forest growth.

All the trees of the sub-Arctic forest are found in this region. The black spruce is most abundant and constitutes at least three-

fourths of the forest. It is almost abundant in the valleys, where it forms close thickets of small trees whose branches extend to the ground. On the sides and tops of ridges the growth is larger; many of the trees would cut to logs of twelve inches in diameter while some of the larger would give logs of eighteen inches. The greater number of the trees will, however, be found useful only for pulp wood. White spruce is found on the ridges, where trees up to twenty-four inches in diameter are common and in many places numerous enough to permit of profitable lumbering if any means existed for transport to the southern markets. Larch formerly grew in abundance on the swampy ground along the banks of the sluggish streams and often the trees exceeded the white spruce in size. Some twelve years ago a pest of the European Larch saw-fly traversed the country and at present not one in ten thousand of the large trees survives; the only ar[illegible] now remaining are the small trees that have grown up since the pest passed away. The old trees still stand as skeletons on all the swampy grounds and are not pleasing features of the landscape.

Banksian pine is found everywhere with spruce and reaches a size equal to that of the white spruce. Cedar grows along the edges of lakes and streams; it is often of considerable diameter at the base, but is stunted in growth, and branches a few feet above the ground, so as to be of little value. Aspen grows freely in all the ancient burnt areas, where the land is moderately dry; it is most abundant along with white birch upon the hillsides. Balsam poplar is rare in the district, as there are few suitable places for its growth, such as heavy clay soil in the river-bottoms. White birch is usually abundant on the ridges, where it grows up to twenty-four inches in diameter.

In the region explored, over three-fourths of the surface is covered with old forest or with second-growth of thirty years and upwards. Areas of recently burnt lands and of small second-growth are met with throughout the region, but are not so common nor so extensive as those to the south of the watershed. The fact that the country is thickly wooded and that the surface is usually hidden beneath a thick covering of moss renders prospecting difficult; in places, almost impossible.

In the consideration of the suitability of the lands of northern Quebec for agriculture, differences of elevation above the sea appear to be more important factors than do differences of latitude. Where lands are situated above the thousand-foot level there is constant danger of heavy summer frosts, though these would probably be lessened by clearing the lands and breaking the surface with the plough. As the lands under consideration are from 900 feet to 1,500 feet above the sea, it is doubtful if they will ever be valuable for purposes of agriculture, but they may serve as grazing lands.

At the Hudson's Bay Company post situated on the shore of the

southwest bay of Mistassini lake and at an elevation of 1,200 feet, great difficulty is experienced in growing a small crop of potatoes, although the soil is the best in the region. There, the average temperature for the three summer months is 60° F. and heavy frosts occur late in June and in August, so that the tops are always killed before the potatoes ripen. Attempts have been made at this place to grow oats, barley and wheat, but without success. The Hudson's Bay Company post of Waswanipi is situated on the shores of Waswanipi lake, at an elevation of 700 feet above sea-level, and a few miles beyond the western limit of the map. The climatic conditions are more favourable there and excellent root crops are grown annually, while experiments with the cultivation of cereals show that oats, barley and the hardier varieties of wheat easily ripen.

The fisheries of the larger lakes will undoubtedly be a source of considerable wealth to the province as soon as a railway provides quick transport. The chief food fishes are: lake trout, brook trout, pike, pickerel, sturgeon, whitefish and two species of sucker. The lake trout is found in all the large lakes, and grows to great size in Chibougamau and Mistassini lakes, all the fishes of the latter lake being noted for their size, numbers and quality. Brook trout are plentiful in many of the lakes and especially so in Wakonichi and Mistassini. Unfortunately, they are not numerous in many of the streams, probably owing to the numbers of pike and pickerel in those waters; as a consequence there is little fly-fishing. Whitefish of good size and quality are found in almost all the lakes, great and small. Pike and pickerel or doré, often of large size, abound in all the waters along with the suckers, while the sturgeon appears to be confined to the tributaries of the Obatogamau river, where many are taken by the Indians in September.

DETAILED DESCRIPTION OF THE ROUTES.

Obatogamau Lake.

Obatogamau lake is the first large body of water beyond the height-of-land from the headwaters of the Nikabau river. The portage route enters it by a stream which empties into a small bay at its eastern end. The discharge of the lake is at the western end and a straight line between it and the entrance is eleven miles long while its general direction is about west-northwest. Owing to the crookedness of the lake the canoe track between these places is sixteen miles in length.

The lake is very irregular in outline, being broken by many long bays at right angles to its general trend; it is almost separated into six lakes by five contractions. It is crowded with islands and the

route between them and through the narrows being without distinctive land-marks is only followed with difficulty. The first narrow place is situated five miles to the west of the entrance ; to reach it, canoes follow a course around a mass of islands filling the northern part of the lake, and in doing so, the route passes close to the points separating five long narrow bays which indent the southern shore. A small stream entering at the head of the fourth bay is used as a canoe route to the large lakes of the southwest, drained by the Opawika river, another branch of the Nottaway. Three large bays on the north side of this portion of the lake are crowded with islands. This eastern part of Obatogamau occupies the depressions of a slightly rolling area of granite, the higher parts of which form the rocky shores and islands ; none of these reach an elevation of one hundred feet above the surface of the lake. There is a change from granite to green schist at the ends of the southern bays where the hills are slightly higher and the country more broken.

This first contraction is nearly a mile long and varies from fifty to three hundred yards in width; beyond its western end the direction of the canoe route changes to northwest for two miles passing between granite islands and leading to the second or Lemoine narrows. Between the narrows the lake widens out into two long bays, one on each side, with a distance of four miles separating their heads.

Lemoine narrows are only a few hundred yards long and less than fifty yards across in the most contracted part. The western end terminates in the third expansion, where an irregular bay leads north for four miles to the inlet of a small stream used as the portage route to Chibougamau lake. The third contraction is found by following the south shore of the lake for a mile and a half from Lemoine narrows ; it is a mile long and, passing southward, ends in a long bay, filled with islands, that extends far to the southward. To reach the discharge of the lake, the north shore should now be followed as the next two narrows are on that side and they are very contracted and easily missed. Beyond them the lake extends far to the southward in a large bay crowded with islands, while the discharge flows out of a small northern bay.

To the westward of Lemoine narrows the rocky islands and shores are all formed of green schists. The ridges are slightly higher and more pronounced than in the eastern portion but none of the hills rise a hundred feet above the water.

Extensive forest fires have swept the northern shores of the lake from its entrance to the portage route leading to Chibougamau, while smaller fires have destroyed the forest in patches in other parts. These areas are now being covered with small second-growth aspen, birch and spruce. The old forest is composed largely of black spruce, usually under twelve inches in diameter. White spruce, balsam fir, banksian pine, cedar, aspen and birch make up the remainder and never grow large.

The water of the lake is dark brown in colour and is [illegible] Whitefish, pike, pickerel and suckers are plentiful in parts, while sturgeon are caught in the western bay near the outlet of the lake.

Between Obatogamau and Chibougamau Lakes.

The portage route between Obatogamau and Chibougamau lakes is three miles long; it first follows the small stream which falls into the southern bay of Obatogamau, already mentioned. Three portages are necessary to pass long shallow rapids in the stream, which is difficult to ascend in low stages of the water. The fourth portage leads across a small swampy lake at the head of this stream to the headwaters of another which empties into Chibougamau lake. The southwest bay of Chibougamau is four miles distant and is reached by passing through a number of small lake-expansions on the stream as it flows in a sluggish manner through a swampy country broken at intervals by low rocky hills. The greater part of the country between these large lakes has been traversed by fire and is now being reforested with small aspen, birch, banksian pine and spruce.

Lake Chibougamau.

Chibougamau, unlike Obatogamau, is a lake of wide expanses which, owing to its low shores, often end in stretches bounded by water horizon as seen from the canoe. The lake is twenty miles long and six miles wide in the main body, with its longer axis lying nearly northeast and southwest. At each end it is broken into long irregular bays by a point, and these bays are again subdivided by minor points. The bays of the west are longer and narrower than those of the opposite side.

The southwest bay extends five miles and a half from the outer Long point, to a short contraction, after which a narrow lake continues three miles to its head. The distance from Long point to the head of the southeast bay is about four miles and it is about the same distance from the point across the mouth of the bay to the southeast shore of the lake. The shore line at the head of this bay is [illegible] small bays, the western of which receives the small stream used as a canoe route to Obatogamau lake.

The northeast or McKenzie bay is irregular in shape and has a narrow [illegible] head, where the portage road to [illegible] McKenzie bay is the most important [illegible] bearing serpentine [illegible] is found in its vicinity.

Island bay forms the northeastern part of the lake; it stretches six miles from Sorcerer point to its head, while its general width exceed two miles. As its name implies, it is covered with islands of all sizes, generally low and thickly wooded. The shore line is also rocky, and broken into irregular bays, while the water is shallow, in distinction to other parts of the lake, where it is usually cold, clear and deep.

A number of islands form a loose string between Sorcerer and Long points, while others fringe the shore of the southern bays. The shores of the lakes are generally low, with rocky points separating long stretches of beach formed of boulders tightly packed ' the ice into dry walls, often rising several feet above the summer level of the water. A number of small streams empty into the lake, but none of them are of sufficient size to be navigable with canoes for ten miles above their mouths.

Chibougamau discharges by two streams from its western side into the adjoining Doré lake. The discharges are about two miles and a half apart, being separated by Paint Mountain island. The southern has a direct fall of twenty feet, is twenty feet wide and four feet deep, with a current of about four miles an hour at low stage of water in the lake. This fall might easily and cheaply be converted into power. The other discharge flows out of Portage bay on the north side of the island, in descending to the level of Doré lake, falls with strong rapids about one hundred yards long. This stream might be closed at a small expenditure, thus increasing by one half the volume of the other.

The country about the eastern and southern parts of Chibougamau is low and is broken only by low hills of gabbro and granite. Similar conditions prevail along the southern half of the western side occupied by these rocks, but as an approach is made to the southern discharge the rocks change to green schists which rise in low cliffs from or near the edge of the water into hills between two hundred and three hundred feet high. Paint 'Mountain,' noted for its ledges of gold bearing quartz, and for the presence of copper sulphides in its rocks, hardly deserves the name, as its highest point is not much over two hundred feet above the lake.

The country about McKenzie bay forms part of the southern chain of hills already described as crossing from east to west. On the south side of the entrance to the bay is Sorcerer mountain, a hill upward of 1,500 feet in elevation and formed largely of coarse gabbro. Farther up the bay, on the same side, the hills are somewhat lower and are composed of green schists and serpentine. These continue until broken by the valley of Rapid river, a small stream flowing into the eastern end of the bay. On the west side of the entrance, rough hills of conglomerate and schist occupy the peninsula between McKenzie and Portage bays, while to the north and northwest of the head of the former, hills of serpentine, schist and diabase rise from 500 to 700 feet above the lake.

At the head of the valley leading from the west end of McKenzie bay, and about two miles distant from its shore, is a peculiar, sharp peak whose summit rises to an elevation of 550 feet, which from its shape is called by the Indians Juggler's House. About a mile to the north of this peak is Canning mountain, formed of diabase and serpentine and probably 200 feet higher than Juggler's House, being the highest hill in the vicinity. Near the western end of McKenzie bay, and close to Asbestus island and to the portage leading to Wakonichi lake, is a low cone of dark rotten serpentine peculiar on account of its magnetic attraction, the compass pointing to it from all directions within a radius of half a mile.

Fire has caused great destruction to the forests on the shores and islands of Chibougamau lake and only small areas of the old forest remain. The country surrounding the southern half of the lake has been totally burnt over in recent years and is now either bare, or is covered with small second-growth trees. In other places the area of a great fire, which swept the country some thirty-five years ago, is marked by a thick growth of small aspen and birch of that age, with younger spruce growing up between them. The small patches of ancient forest on points and islands contain many trees of black spruce up to eighteen inches in diameter and, along with them, larger trees of white spruce, birch and balsam fir, together with a few banksian pine, aspen and cedar.

The deep, cool waters of the lake are well-stocked with large and finely flavoured lake-trout, whitefish, pike and pickerel and, in certain parts, with brook-trout up to four or five pounds in weight. The best localities for angling are at the narrows leading to McKenzie bay; between Malloch island and Sorcerer point; at Long point, and along the shores of Paint Mountain island.

Route between Chibougamau and Wakonichi Lakes.

The portage route to Wakonichi lake leaves the western part of McKenzie bay from a small cove behind Asbestus island; for a hundred yards it passes over a swamp caused by the soakage from a large spring of ice-cold water which bursts from the ground alongside the road. The portage then rises gradually 300 feet over burnt hills to a small lake three-quarters of a mile away. From the eastern corner of this lake a portage a quarter of a mile in length leads to a second small and crooked lake which is followed about a mile and a half to the small stream entering it, and this is ascended a short distance. Then follows a portage of three-quarters of a mile ending on a small stream emptying into the third lake. After a short stretch of river a portage of 200 yards passes a rapid and ends in this last lake which is about a mile across the portage from its northwest bay.

The last portage is 1,200 yards long and leads down hill to the shore of a small cove on the west side of the southwest bay of Wako-

nichi lake, whose water-level is about two hundred feet above that of Chibougamau.

The country along the route is rough, being formed of low ridges of east-and-west hills with swampy land in the valleys between. The greater part of the old forest has been removed by fire, and what remains is largely black spruce with white spruce and aspen, all corresponding in size to the trees found about Chibougamau lake.

Wakonichi Lake.

Lake Wakonichi is parallel with, and to the northeast of, Chibougamau, and lies in the depression along the north side of the watershed which, farther north, constitutes the basins of Great and Little Mistassini lakes. In physical character, Wakonichi differs somewhat from the large lakes already described, being long and comparatively narrow, with generally steep shores and few islands. The greatest length from the head of the southwest bay to the outlet at its north end is twenty miles; its greatest width is three miles across the mouths of the northern bays.

The shape of the lake bears a rough resemblance to that of a plough, the long northeast bay representing the beam, the northeast bay the ploughshare and the southern bays—by a wide stretch of imagination—the handles. At the southern end the western side is broken by three long narrow bays, separated by ridges of schist and conglomerate which rise from 200 to 300 feet above the water. A similar bay on the opposite side of this end of the lake is separated from the main body by a narrow ridge of drift-covered schist. This bay is split in two by a long, irregular point projecting from its head. The general direction of these southern bays is only a few degrees west of the main axis of the lake, which lies approximately northeast and southwest.

The southeast side of the lake is bounded by ridges of drift-covered schist that rise steeply from the water to elevations varying from 70 to 300 feet. The shores here are nearly straight with few exposures of rock, the shore line being often lined with a low wall of tightly packed boulders. Towards the northeast end of the lake the height-of-land is approached, so that along the south side of the long narrow bay leading to the discharge the country is higher and more broken, while low cliffs of arkose and conglomerate are not infrequent. The northern side of this bay is bounded by a narrow margin of low ground to the foot of a scarped ridge formed of schist arkose and conglomerate which rises from 300 to 400 feet above the water. These hills with one break, extend to the end of Specular point which separates this bay from that on the northwest.

Rounding Specular point, a granite area is reached with a change in the physical features: the northwest bay is shallow and

is dotted with a number of small granite islands. The head of the bay is bounded by low sandy shores with swampy land covered with black spruce, where a narrow ridge separates Wakonichi from a lake extending for some distance northward, along the western side of the conglomerate ridge. The western side of the bay is irregular, with many rocky points and islets of granite backed by a rolling country of no great elevation. A few miles beyond its mouth, and within a mile of the shore of the lake, a solitary hill of granite rises to an elevation of 575 feet above the lake. From this conspicuous landmark an excellent view of the surrounding country is obtained. To the eastward, beyond the lake, is seen the almost level ridge of the height-of-land rising some 300 or 400 feet above Wakonichi; in the southeast are a few isolated hills extending from the watershed to the hills about the north end of Chibougamau, while these are seen continuing far to the south and westward. To the west and northwest is a rolling country with ridges of rounded hills, none of which reach an elevation equal to that of the granite hill.

Included in the view are two lakes to the south of Wakonichi, parts of a small chain drained by a stream which flows into the large lake a short distance from the discharge. In a valley running north, portions of a similar chain are drained by a small branch of the Chibougamau river and form a portage route between Wakonichi and that stream, the route leaving the lake from a small bay close to the eastern foot of the hill and passing over swampy ground along its eastern base.

The granite, with its characteristic broken rocky shore and islets, occupies the western side of Wakonichi for about three miles to the westward to this portage; then follows an interval of low sandy shore until the schist and conglomerate again outcrop behind a long low island. Continuing southward, the shores again become higher and afford an almost continuous exposure of schist and conglomerate, which, in many places, is brightened by a covering of the orange-coloured lichens that give the lake its Indian name. The cliffs continue to increase in elevation until the ridges separating the southwest bays are reached, where they rise directly from the water to heights of 200 feet or more. As the bays are ascended, the cliffs become lower and are not continuous, the shores becoming wooded to the edge of the water, while the general level of the country is lower and often swampy.

The waters of the main body of the lake are deep, cool and clear; the bays are shallow towards their heads and shallow water is general in the northwest bay where the granite prevails. A few small islands are found in the southern bays, with a larger one between the bays and the main body of the lake, and another in mid-lake a couple of miles to the north. The other rocky islands of the granite area have been already referred to.

No streams of importance flow into Wakonichi excepting perhaps a small river at the head of the southeast bay and another on the south side near the discharge of the lake; both are used as hunting rivers by the Indians.

Evidences of the great fire of thirty-five years ago are seen in the small birch, aspen and spruce trees now growing over the greater part of the country surrounding the lake. Later fires have destroyed large areas around both shores and are now marked by a smaller second-growth. The small patches of the old forest remaining are very similar in size and species to those already described.

The cold clear waters of Wakonichi swarm with large lake-trout, brook trout and whitefish, with lesser numbers of pike, pickerel and suckers. The evidences of Indian encampments show that the best fishing places are at the end of the point dividing the southeast bay from the main body of the lake, and at Specular point, where, in former years, the Hudson's Bay Company made their autumn fishery for trout and in a few days took many barrels of fine fish for the winter supply of their post on Mistassini lake. This fishery is now abandoned for a more convenient one on the great lake.

Wakonichi Lake to Mistassini H. B. Post.

Wakonichi lake discharges northward into the southeast bay of Mistassini, and so into the Rupert river. Where the river leaves the lake it is contracted to less than twenty yards, with a strong current passing between loose blocks of rock. After a few hundred yards of lake expansion the stream falls about thirty feet through a low gorge where there is a portage of a quarter of a mile. Then follow more lake expansions, ending in a stretch of river with a rapid at its head, and another where it empties into the southwest end of Mistassini. A portage is necessary to pass the lower rapid in ascending the stream.

Only the southern portion of the irregular southwest bay of Mistassini lake is included within the limits of this report. This bay is broken by long points of flat-headed limestone or drift into smaller bays, while its surface is partly covered with islands of limestone, some of which are of considerable size. A change in the physical character of the country occurs in passing from the hard crystalline rocks to the softer limestones. The lands about the bay are moderately high and flat, being formed of modified ridges of glacial drift. The soil is much better and supports a larger growth of trees in which aspen is plentiful.

The Hudson's Bay Company's post is located at the Little Narrows, some sixteen miles from the head of the bay.

Mistassini lake is a hundred miles long and has a maximum width of twelve miles. This great body of water contains a large supply of excellent food fishes including large lake-trout, brook-trout, whitefish, pike, pickerel, suckers and the fresh-water cod or maria.

Chibougamau River.

As already mentioned, Chibougamau lake discharges by two streams on its western side both of them falling into Doré lake. A considerable body of water lying parallel to Chibougamau. The northern discharge empties into the head of this lake, which is some twelve miles in length to its outlet at the southeast end. Its shores are somewhat irregular so that the lake varies from half a mile to two miles in width; it has a few minor bays on both of its longer sides, while a number of large islands block the lake near the middle of its length and smaller ones occur sparingly elsewhere. The northern end is surrounded by an extension of the rough hills, 300 to 600 feet high, found about that end of Chibougamau. These hills extend about half way down the lake on the west side, and somewhat farther along the opposite shore, until they give place to the rounded granite hills separated by wide swamps which characterize the southern shores of Chibougamau.

A considerable area of old forest occupies the western shores and islands, where large trees of spruce and birch are numerous.

The river discharges from the western bay at the south end of Doré lake and flows southwest for three miles with a moderate current between muddy banks. The country behind is low and flat, and has been mostly burnt by an ancient fire and by others of recent years. The small patches of old forest remaining are composed largely of medium-sized black spruce on the east bank with larger trees including white spruce and birch on the opposite side.

The river is blocked with islands at the end of this stretch and breaks into short rapids between them as it falls into a long narrow lake expansion which continues in the same southwest direction for five miles. The river leaves this expansion by a northern bay on the west side near its middle and after a north course of two miles turns westward for a like distance, where a short stretch of swift current leads into a second expansion. This in turn is divided from the southeast arm of David lake by a heavy rapid four hundred yards long. The general direction from the outlet of the first expansion to the main body of David lake is about northeast, while the distance is five miles.

David lake is a small, irregularly shaped body of water covered with islands and indented with many small bays. Its longer axis lies northeast and southwest, the length being about two miles and a half and the greatest width two miles. The river flows out of a small bay on the west side and is somewhat difficult to find. The country surrounding the above lakes never has an elevation of fifty feet above the water level and similar flat swampy lands appear to extend far to the southeast, south, and southwest, while the higher gabbro hills from the west side of Doré lake continue westward and pass within a mile or so of the north side of David lake. Much of this country

...as been burnt over and is now covered with two or three sizes of small second-growth. As the lands are usually swampy, black spruce is the most abundant tree, with birch, banksian pine, white spruce, ...spen and fir on the low rocky ridges, none of them reaching a diameter of eighteen inches.

Green schists occupy the southern and western parts of this area while, in the northern part, especially about David lake, the rocks are largely gabbro.

The river leaves David lake by a strong rapid about 500 yards long with a portage, used in ascending the stream, leading from its foot over a ridge to the next bay north of the one by which the river discharges. A stretch of strong current and lake expansion is followed by another short rapid where the river empties into the southwest bay of Simon lake. The general direction of the stream between David and Simon lakes is about southwest, and the distance three miles.

Simon lake is roughly V-shaped, the southeast bay being shorter than the other limb, so that it is about six miles from the inlet to the head of the north bay, while the distance from there to the head of the southwest bay is ...out eight miles. The lake is dotted with many islands and broken by points into small irregular bays. The surround... country is somewhat rougher than that previously described; ...ay low ridges of rock, never elevated more than a hundred feet above the surface of the lake, characterize the shores. Over one-half of the trees have been removed by recent fires, the standing timber being similar to that about David lake. The rocks—gabbro, gneiss and schist—are seen in many places.

The river flows out of a narrow bay situated near the middle of the northwest shore, and separated from the main body by a long narrow point. This bay passes north for a mile when a quick turn is made to the south, where a heavy rapid 200 yards long ends in a small bay which opens into the southern side of Asinitchibastat lake, some four miles from its south end.

Lake Asinitchibastat is narrow, being not much more than a mile across in its widest part and usually about half a mile wide until it gradually narrows to a hundred yards at its north end, and so passes from lake to river. Its total length is sixteen miles and, with the exception of one short bend to the westward near the middle of its length, it runs almost straight from southwest to northeast. As a rule the banks are moderately high and rocky; consequently, along the northwest side there is an almost continuous exposure of schist and diabase rocks. Though frequent, the exposures are not so numerous upon the opposite shore. The lake passes through two ranges of sharp isolated hills, the southern range being south of the western bend, the other and higher being some four miles north of that place. These hills are separated by a wide flat valley and, from their eastern trend, they must be extensions of the rough country between

Chibougamau and Wakonichi. Beyond the northern range, the country becomes low, flat and swampy, with only low knolls of rock breaking the general level. Most of the forest has been destroyed by fire; what remains on the low lands is almost wholly black spruce of small size. On the hill-sides, larger white spruce, banksian pine and aspen grow to a size larger than that of any of the trees yet noted. A small stream occupies a valley in the northern range, and may serve as a portage route to the southwest bays of Wakonichi.

As the northern end of the lake is approached its direction changes more to the northward or diagnoally away from the rough country, and its banks become low and sandy. From the outlet to the junction with the small branch already referred to, which rises in the granite country of Wakonichi, the direction of the river is due north and the distance is ten miles. The distance by river is considerably greater as it makes a detour to the northeast and then back to northwest flowing with a sluggish current in a crooked channel between low banks of mud rising into flat swampy land behind and broken only by inconspicuous hills on the west side. There is a short heavy rapid about two miles above the fork. The branch appears to have a character like that of the main stream, its volume being about a third of that of the larger.

The united stream below the junction turns abruptly to the southwest thus flowing in a line parallel to, and about ten miles to the north of, its former course through Asinitchibastat lake. For three miles below the forks it retains its former sluggish character with low banks apparently built above the surrounding swamp. It then empties into the head of Rush lake so named from the quantities of rushes that choke the inlet and the bays on both sides. The lake is six miles long and is surrounded by swampy country from which rise many low hummocks of rock. Another three miles of sluggish current and flat country lead to Little Rush lake, a mile across, and so filled with rushes that only a narrow channel for the river is free of them. A river stretch of half a mile leads from the west end of this lake into the eastern end of Five-mile lake where the surrounding country becomes somewhat higher and dryer with frequent rock exposures on its shores and islands. Towards the southwest end the hills rise to elevations ranging from 200 to 400 feet above the water. They have been recently burnt over in parts, the standing timber consisting of merchantable white spruce, birch and aspen, along with smaller black spruce.

The river passes out of the head of a western bay near the southwest end of the lake, where it is broken into three channels by islands. The eastern channel is the canoe passage, where a short strong rapid is descended to a small quiet basin out of which the river falls twenty feet into the eastern end of Opemiska lake. This lake is ten miles long from east to west and lies along a contact of diabase and granite, the latter occupying the southern shore and islands. The

lake, broken as it is, by long points, varies greatly in width. Three miles from the inlet it contracts to less than a quarter of a mile with shallow water except for a narrow channel cut in the sands close to the north shore. The western portion has a number of long bays on both sides and its expanse is marked by many islands of granite. The country surrounding the eastern portion is nearly flat with low rounded ridges. Towards the west end the country becomes higher with rugged granite hills to the south and west, while a conspicuous hill of gabbro rises from the shores of the north side close to the western end of the narrows and is continued westward to Mikwasach lake. Many fine clumps of spruce, aspen and birch grow on the points, while much of the forest about the bays has been destroyed by fire.

The lake discharges from behind an island in a small cove near its west end where it immediately falls ten feet in heavy rapids passed by a portage of 250 yards. Three miles of expanded river lead westward to a sharp bend to the north where strong current for half a mile ends in the head of the southwest bay of Mikwasach lake. The country surrounding this portion of the river has been burnt over in recent years and only a small growth of aspen and birch occurs in patches to relieve the glaring white of the surrounding granite hills.

Mikwasach is another V-shaped lake with its apex towards the west, the southwest arm being three miles long, while the northwest is nearly five miles in length. The surrounding country is rough and rocky with bare granite hills at the eastern end; the unburnt northwest bay has almost an alpine aspect in comparison with the generally flat scenery of the region. There the rugged granite hills rise abruptly from the shores to heights ranging from 300 to 600 feet, their slopes being partly covered with small trees of spruce and birch while the surface of the bay is dotted with high, rocky and wooded islands. The southern and western parts of the lake are underlain by granite but the northern shore is formed of dark basic rocks.

The river flows out near the middle of the northern shore. Small islands break it into a number of channels immediately below where it leaves the lake and it descends between them with short rapids into an island-covered expanse about a mile across. The stream then contracts and for the next mile passes through a low gorge, falling fifty feet as it breaks through the western extension of the gabbro hills. A rough portage of 1,200 yards passes this obstruction. The river below the portage continues northward for three miles and is broken by a short rapid and a fall of eight feet; it then turns to the west for a mile to be joined by a smaller north branch called Brock river. The canoe route leaves the main stream about half a mile above the junction and crosses a flat sandy plain for half a mile to the smaller river in order to avoid heavy rapids on the larger.

Brock river has not been explored, but the Indians say that it drains a goodly part of the country between Obatogamau and the headwaters of the Broadback river and that it is an occasional route to the southwest bay of Mistassini lake. Where it joins the main stream it has a general width of 100 feet and appears to discharge about a third of the volume of water carried by the larger branch. The country about the forks is fairly flat with low domes of diabase rock rising a few feet above the general level. The trees are medium-sized second-growth black spruce and banksian pine.

From the junction with the Brock branch to that with the discharge of Obatogamau lake the river, with minor bends, flows towards the southwest. The distance in a straight line is twenty-six miles but owing to a considerable curve to the northward it is upwards of thirty miles between these places by the stream. The river below the junction with Brock river has an average width of two hundred feet and flows with a moderate current between definite banks, from five to twenty feet high, usually thickly covered with willows and alders to the water's edge. The stream is unbroken for fifteen miles, when a short rapid occurs at a northern bend; it is followed, three miles below, by a heavy rapid half a mile long caused by low hummocks of rock in the bottom of the river. A short stretch of quiet water then leads to another rapid a third of a mile long where the river widens to upwards of 400 yards and passes over boulder bars. The current is sluggish for the next four miles and the channel obstructed by a number of small islands; then come the final four miles of swift water with two heavy rapids and several shallow ones which continue to the junction with the Obatogamau river, the rapid at the forks being so shallow that the united stream must be descended half a mile before a crossing can be made into the channel of the smaller stream.

The country along this portion of the river is everywhere nearly flat, its level being broken only by a few rocky knolls that appear to run in chains from east to west. The greater part of the surrounding country has been burnt and is either bare or covered with small second-growth banksian pine, spruce and aspen. The trees of the small patches of old forest are not large and are chiefly banksian pine and spruce.

Obatogamau River.

The river which discharges Obatogamau lake, as already described, flows out of a small northern bay near the west end of that lake. At the outlet the river falls eight feet over a ledge of schist, the stream having a width of about twenty feet. After a short rapid it widens out to a hundred yards or so as it passes north for a mile and a half and then southwest for a mile into the head of Mukwacha

lake where the low ridges of trap give place to a more rounded granite country. Mukwacha lake averages half a mile in width and for three miles and a half from the inlet has a northerly course; it then bends to south-southwest and continues in that direction to the contraction joining it with Eau Jaune lake. The southern arm is marked by a number of large islands of granite which nearly fill a large bay on its west side. Approaching the point where the lake bends to the west there is a peculiar narrow ridge of boulders rising above the water and stretching almost across the lake. The western arm is dotted with islands only towards the discharge; its shores are sandy and without exposures of rock.

The narrow channel connecting with Eau Jaune lake is short and ends in its island-covered northeast bay. Eau Jaune lake is seven miles long from north to south and about five miles wide. Its shoreline is very irregular with long narrow bays running in all directions, while its surface is crowded with islands of all sizes and shapes formed of knolls and ridges of dark schist. The crooked channels between islands and into bays are very bewildering and it is difficult for even the Indian guides to find the way between the inlet and a portage in a bay on the west side which leads past rapids in the river below the outlet. The river flows out of another bay in the northwest part of the lake, the portage bay being two miles to the south of the discharge. This portage is over a mile long and the greater part being through swamps, its passage entails much hard labour; it ends at the mouth of a small brook which joins the main stream where the latter bends northward on its way from the lake. From the portage, the river flows through narrow, shallow lake-expansions for two miles to its entrance into the north end of the eastern bay of Presqu'ile lake. This lake is so called from the peninsula which projects from the north side and so divides the lake into two bays, of which the eastern one is narrow and so contracted at its mouth that difficulty is experienced in finding it when approached from the main body of the lake. The western bay is four miles long and has an average width of a mile, with clusters of small islands in its northern part.

The country surrounding the lake is slightly rolling, with rounded hills of granite on the south side while those to the north are formed of dark schist. A goodly part of the country between Obatogamau and Presqu'ile lakes has been traversed by recent fires. The standing timber is at least four-fifths black spruce, the remainder being white spruce, banksian pine, birch and aspen with cedar along the water's edge. None of the trees are sufficiently large to cut into boards, but a great many of them would make excellent pulp wood.

More than half of the surrounding country consists of swamp with ridges and knolls of rock never rising a hundred feet above the water.

The outlet of Presqu'ile lake is in its southwest corner, where the river leaves with a rapid and fall of ten feet. The distance from there

to the junction with the Chibougamau river is thirty-three miles in a straight line whose direction is west northwest. The river however, in places is very crooked so that the distance by it is twice that of the straight line. Its character is very uniform throughout; it flows through a flat swampy country and has a sluggish current, except at rare intervals where it breaks through low ridges of rock or drift, and where heavy rapids occur. The banks elsewhere are low and muddy and in most places appear to have been built by the river a few feet above the swamp in rear. Where the bank is at all dry the prevailing tree is bank-ian pine; in the swampy ground, only black spruce and larch have grown, the latter, having been all killed by the larch saw fly some fifteen years ago, stand as skeletons to mark the crooked course of the river.

Between the tenth and sixth miles above the junction with the Chibougamau river the stream skirts, in a peculiar manner, the sides of four small lakes being separated from each by a low bank of mud with openings into the lake. These are favourite fishing places for the Indians who catch large numbers of sturgeon there in the autumn. Below those lakes, the descent of the stream is steeper and rapids are numerous, the last one carrying the river to its junction with the larger Chibougamau. Along the upper crooked stretches below Presquile lake, the stream rarely exceeds fifty feet in width, and grades in its course to one hundred feet in the lower parts.

GEOLOGY.

General Description.

Owing to the general disturbed condition of the rocks and to the presence of intrusions of igneous masses, both acidic and basic, in many parts of the country, the geology of the region included in this report is varied and complicated.

The region, as a rule, is nearly flat, so that no considerable section can be read as found in cliffs, as in other places. Large areas are covered with swamps, from which only occasional small knobs of rock rise above the level of the water, rendering the interpretation of the geology a matter of opinion rather than one of fact. The surface of the dry land is usually thickly covered with dense growth of small spruce, while a deep deposit of muskegs conceals areas of rock that would otherwise be easily seen.

These conditions and drawbacks render the following geological description largely to the rocks found along the waterways and to the exploration, and by geological colouring of the map which accompanies this report, whether any attempt is made to indicate areas

of the ancient rocks called Kewatin, while the overlying conglomerates and arkose are taken to be Lower Huronian. In the region under consideration this contact of conglomerates with underlying contorted schist was not seen, the only contacts observed being between the conglomerate and the underlying granite, but, as already stated, the conglomerate usually contains boulders of a more ancient basic schist, and the arkose in places consists of fine material such as would result from the decay of such schists. Thus, there is little doubt that the old Kewatin schists do, in places, underlie the bedded series here in a manner similar to their occurrence west of Timiskaming lake.

The contact between these Lower Huronian rocks and the Upper Huronian limestones of Mistassini is also hidden. The latter are somewhat disturbed near the contact and probably rest unconformably upon the broken and tilted beds of conglomerate at the south end of the lake. The absence of diabase irruptions in the limestones also points to a considerable time break between the deposition of the Lower Huronian and these practically undisturbed limestones and cherts.

Small areas of highly crystalline gneisses and schists are seen in a few places in this region, notably along the eastern and southern shores of Chibougamau lake, along the Chibougamau river, at and above Asinetchibastat lake and on the Obatogamau river. These rocks resemble the schists and gneisses of the Grenville series of the Laurentian, and they may in part represent ancient sedimentary rocks, but they are now so altered and crystallized as to leave no trace of such an origin. There is no proof against the supposition that these highly crystalline rocks may only represent a more highly metamorphic and squeezed condition of the less altered diabase and granite rocks found on all sides of them. This seems to be the case in a number of localities where there appears to be a gradual change from unfoliated granite and nearly normal diabase rocks to these highly crystalline gneisses and schists.

The undoubted igneous rocks are represented by a number of different areas of both acidic and basic constituency. The basic rocks are most widespread and probably represent three or more outbursts separated from each other by long intervals of time. The greater part of these rocks are medium to fine-grained diabase rendered more or less schistose by pressure and often by decomposition to chlorite and allied schists. As before stated, it is exceedingly difficult to distinguish between areas of different age in such rocks without actual contacts of the older and newer series and, unfortunately, no such contacts were observed in the region. If areas of the old Kewatin schistose diabase do outcrop there, they were not recognized and are in consequence included with the diabase and diabase schists which include masses of the conglomerate and arkose. The diabase is only foliated in places, and considerable areas may be found where it lies almost flat or in rounded low domes.

Diabase and its alteration products and schists, together with its associated conglomerates and arkose, underlie more than half of the region embraced by this report. Starting from the contact with the overlying limestones of Mistu-sini in the northeast corner of the map, a wide band stretches away to the west and southwest embracing the greater part of both shores of Wakonichi lake and extending thence to the northeast part of Chibougamau, where it is cut off by newer gabbro and granite. The diabase again appears in the southwest part of that lake and continues southwest to Obatogamau lake where it widens and embraces the area extending from the granite in the eastern part of Obatogamau lake to that of Presqu'ile lake, some twenty miles to the southwest. The western extension of the Wakonichi area of these rocks extends from the west side of the granite area there across to the Chibougamau river and then westward, embracing the country about Rush and Five-mile lakes and so to the north side of Opemiska lake, where it is cut off by a mass of gabbro. Its southern boundary to that lake is determined by the irregular outlines of the masses of granite and gabbro which separate it from the southern area of Obatogamau lake. To the northward of the granite and gabbro of Opemiska lake diabase and diabase schists are found along the Chibougamau river to its junction with the Obatogamau river, a short distance below which it is replaced by granite on the south. In addition to these large areas of diabase, smaller areas are found filling intervals between the different masses of granite and gabbro in the central part of the map, while small bands of the green schists are often seen inclosed in the masses of both these rocks.

The diabase lies in wide horizontal masses whose upper surfaces have been worn by denudation and ice-action into low domes and hummocks, where it is seen in an undisturbed state, and where it has not been rendered schistose by pressure. This state of the diabase points to its eruption by vents leading from the interior to or near the then thin crust of the earth. If the diabase spread out in great sheets or laccolites between different beds of stratified rocks in a manner similar to the eruptions about Thunder bay, Lake Superior, all traces of these overlying beds have been removed by denudation, and if the outflow was on the surface, as is the case along the east coast of Hudson bay, erosion has carried away all the upper part of the mass which would have shown an amygdaloidal structure due to the expansion of gases contained in the molten mass near the surface. Owing to the absence of any evidence the manner of eruption can only be said to belong to one of these two classes.

The vents connecting the interior with the sheets of diabase may, in part, be represented by the masses of serpentine found about the shores of McKenzie bay, Chibougamau lake, which have a probable extension from there both to the east-southeast and west-southwest in the rough country of the southern ridge, already noted as crossing the

region in those directions. This serpentine is now in the form of long narrow bands associated with similar bands of diabase schist conglomerate and arkose all due to the flattening and lengthening of masses of these rocks by pressure. The serpentine forms two, and perhaps three, such bands stretching for several miles along the shores of McKenzie bay. This rock is a decomposition product of a coarse diabase rich in olivine, and, following the ordinary law that in eruptions the more basic material flows out last, it probably represents the last outflow of the diabase eruption which filled the vent and cooled there. Evidence is lacking to prove conclusively that the serpentine belonged to the eruption of the Lower Huronian diabase and not to the previous eruption of Keewatin age.

The gabbro and anorthosite rocks of the region are probably different phases of one irruption. Their coarse crystalline texture points to slow cooling at a considerable depth below the surface, while their contact with the diabase schist shows that they penetrate the latter and are consequently newer in age. The largest mass of these rocks is irregular in shape and extends westward from Sorcerer mountain and the northeast part of Chibougamau lake across Doré lake to Simon lake on the Chibougamau river. The second large mass is about three miles wide and extends for several miles east-and-west along the north side of Opemiska and Mikwasach lakes.

The acidic irruptive rocks are represented by three different granites. The oldest of these a red to pink, hornblende-mica-granite is seen about the northeast part of Wakonichi lake beneath the Lower Huronian conglomerate, most of whose boulders are derived from this granite.

A second hornblende-mica-granite is found on the west side of this lake where it cuts the conglomerate and its associated diabase schist, and is, in consequence, of Post Lower Huronian age. This granite is lighter in colour than the preceding and its hornblende often decomposed to sericite, causing the rock to become a protogeo granite. The Wakonichi area probably extends several miles westward and may be connected with the small exposure of granite seen on the Chibougamau river a few miles below Asinitchibastat lake. A large area of similar granite is found in the southern half of Chibougamau lake and extends westward thence across the southern half of Doré lake. It is again seen on the second lake-expansion of the Chibougamau river and then on the western shores of Simon lake and from there to the west side of Asinitchibastat lake. Granite of this type is next met with on the south side of Opemiska and Mikwasach lakes and again directly west along the lower stretches of the Obatogamau river. It is very probable that these several areas join to form one long irregular mass extending from Chibougamau lake to and beyond the junction of the Chibougamau and Obatogamau rivers. When in contact with the gabbro the granite is the cutting rock. Another small area of pink to red hornblende-mica-

granite occurs along the Obatogamau river at Mukwacha lake, this being perhaps a southwestern extension from the area of Chibougamau lake.

The third and probably the newest granite of the region extends from south of the limit of the map and from beyond the height-of-land to Obatogamau lake where it is found as far as Lemoine narrows. Similar granite is met with on the south side of Eau Jaune lake and along the southern and western shores of Presqu'ile lake. It is essentially a biotite-granite, white to light-pink in colour, usually medium to coarse-grained in texture and rarely showing gneissic structure. It is very feldspathic, with dark biotite, and it usually carries little quartz.

The glacial phenomena noted are confined to the direction of the glacial striæ, of which two distinct sets were found, the older being from N. 50 E. and the newer from N. 30° E.

GEOLOGICAL DETAIL

A detailed description of the rock exposures met with along the routes followed is given in the following pages, for the use of the prospector or others going over the region. A concise statement of the geology has already been given and an account of the mines and mineral possibilities of the district follows the present portion of the report; in consequence, a fair idea of the geology and mineral resources may be obtained without reading through the following somewhat lengthy detail.

Lake Obatogamau.

A number of rock exposures are seen about the shores of the small lakes at the height-of-land and in a few places along the stream connected to Obatogamau lake. These consist entirely of a medium-grained light-coloured mica-granite, in which a white or light-pink feldspar predominates and is associated with quartz and an ill quantities of biotite.

Similar granite is found abundantly on the islands and shores of Obatogamau lake, from the inlet to the west shore of the lake at Lemoine narrows, where a change to a dark-green chloritic schist occurs, foliation striking towards the southwest. Schists are also found at the heads of the two longest bays on the west side of the lake before reaching the narrows, and show that the western extension of the granite coincides almost with that of the lake. To the eastward, the contact between granite and schist was not traced but, as a somewhat similar contact is found in the southern part of Chibougamau lake, it is inferred that the granite mass of Obatogamau extends northeastward to the shores of that lake. The granite as a rule is not foliated and has a gneissic structure in only a few places. The schists

be cut by the granite and are but slightly altered by the the only change being a slight increase in the number and ... e quartz stringers cutting them. These stringers hold small ... es of sulphides and are barren of gold. The schists always carry varying amounts of sulphides but are not richer near the contact than elsewhere so that it is doubtful if enrichment zones will be found in them near the granite contacts.

All the shores and islands of that part of Obatogamau lake to the west of Lemoine narrows are formed of more or less schistose diabase in which no large or valuable bodies of ores were seen.

A number of outcrops of similar diabase occur along the portage route leading from Obatogamau to Chibougamau; in places, the light-coloured basic schists are associated with darker sericite-schists containing quartz and these are probably squeezed quartz-porphyry. These schists are occasionally cut by small barren stringers of quartz, the country rock being also barren of economic minerals.

Chibougamau Lake.

The geology of the shores of Chibougamau lake is more complicated than that of the country about Obatogamau. Green diabase-schists and unfoliated diabase are met with in the southern and northwestern parts of the lake, in the latter portion being associated with conglomerate and serpentine. The shores and islands of the northeastern part are composed of a coarse white gabbro, which comes in contact with granite along the eastern shore, with granite and diabase in the southeastern bay and with diabase-schists on Paint Mountain island. Granite rocks are found on the southern islands and along the southern shores of the lake. The contacts between these different intrusive rocks are usually indefinite, one rock grading into the other, so that it is very difficult to distinguish between the older and the newer, in many of the contacts.

Starting from the end of the portage route from Obatogamau and following the shore south and west, the first rocks are seen along the east side of Long point at intervals for a mile and a half to its end. These rocks consist largely of a coarse to medium-grained greenish-gray or pink, mica and mica-hornblende-gneiss, often with an augen-gneiss structure and composed chiefly of feldspar and mica with little quartz and hornblende. Outcrops of a moderately coarse-grained pink mica-granite, at times with a gneissic structure, are numerous on the western side of Long point and on the neighbouring islands. These rocks are cut in a few places by small dikes of fine-grained diabase. The granite in the eastern arm of the southwest bay is more varied in texture and is usually gneissic. Along the east side of the west arm the mica-gneiss varies in texture from fine to medium-grained and towards the head of the arm is associated with masses of a darker hornblende-gneiss which, in some places, is a protogene-gneiss due to

the decomposition of the hornblende to chlorite. This hornblende-gneiss predominates at the head of the arm and there contains bands of fine-grained greenish hornblende-schist.

The prevalent rock along the west side of the bay is a coarse-grained, light-coloured hornblende-biotite-gneiss with little quartz and enclosing fine-grained darker bands of similar composition. Then follows medium-grained biotite-granite gradually changing to a protogene-granite from the accession of decomposed hornblende as the supposed contact with the gabbro area of the middle of the lake is approached. No rocks are exposed along the western shore for six miles, the shores being formed of a wall of irregularly packed boulders. The rocks of the islands lying off this portion of the shore, and those on the western shore of Doré lake, show that this stretch is underlain by gabbro. The western shore again becomes rocky at the mouth of a small cove about two miles south of the southern outlet to the lake. Here, a coarse-grained light-green gabbro, which has suffered much decomposition, is in contact with dark-green schist in a shattered condition. A short distance further north the rock is wholly dark-green schist and contains small, scattered masses of magnetite, evidently a secondary mineral after pyrite. Dark schists containing narrow bands of rusty-weathering dolomite are seen within half a mile of the discharge; they are cut by a few narrow veins of quartz holding small quantities of pyrite. Here also is found a massive diabase decomposed largely to chlorite, but showing its original structure. In places its crystals of feldspar are quite large and the rock thus becomes a porphyry.

The rock in the neighbourhood of this outlet is mostly a fine-grained massive decomposed diabase holding in places masses of epidote and having a considerable quantity of pyrite scattered through it.

Low boulder-strewn banks occupy the shore from the outlet northward to the vicinity of the southeast point of Paint Mountain island. There, dark green diabase and diabase-schist are again found in contact with coarser lighter-coloured gabbro. The first exposure to the north of Copper point shows an altered diabase-porphyry alternating with irregular bands or masses of gabbro. Stringers of copper pyrites occur along the contact of the gabbro and schist at Copper point, while a short distance further south the pyrites are found in the dark schist. Small openings were made on these stringers but they were found not to be permanent and were too small and irregular to pay for mining. The rocks between Copper point and Southeast point are alternately gabbro and schist, the latter predominating. Long tongues or dike-like bodies of gabbro penetrate the mass of the green schists; in like manner bands of the schists run into the gabbro and it is exceedingly difficult to determine which is the cutting rock. The gabbro near the contacts is finer grained and contains more bisilicates than in its normal state away from the contact. These differ-

ences of structure and composition lead to the belief that the gabbro is the cutting rock and that the extra bisilicates were derived by absorption from the schists by the molten gabbro. Pressure exerted after both rocks had solidified caused flattening, stretching and foliation in these rocks, and accounts for much of the complication now found.

The green rocks between Copper point and Southeast point, especially near contacts with the gabbro, are charged with iron and copper pyrites, the former greatly predominating. The rocks on the hill behind are widely stained with iron due to the decomposition of their contained sulphides, which are usually disseminated through the rock but which also occur as small stringers of ore. No location has as yet been discovered where the sulphides are sufficiently concentrated to allow of economical mining.

Passing around Southeast point into Portage bay, the rocks at the eastern base of Paint mountain are largely dark-green schists strongly foliated and much shattered along two lines of fracture. They carry considerable quantities of disseminated iron and copper pyrites and are penetrated by narrow gash veins of quartz and calcite, both holding small amounts of sulphides.

When the first small cove is passed, the shores become low, and the outcrops lie close to the water. Here a light grayish-pink schist is found that appears to be crushed arkose; it is peculiar on account of the quantity of specular iron ore carried as thin partings in the schist. A loose boulder of this rock lying on the beach, and evidently not far from its original site, contained small quartz veins holding specular iron ore along with crystals of copper pyrite. These arkose-schists are associated with small bands of granite-conglomerate, and occupy the low shore to the southwest angle of the bay, when hard green schist and diabase-porphyry are found along the edge of the water to the outlet at the head of the bay.

The shores of the northern side of the bay are lined with boulders or sand without any exposures of rock until within a short distance of the narrows leading to McKenzie bay. On the islands and points at the narrows green schists prevail associated with bands or masses of coarser gabbro. At the point forming the west side of the small bay immediately inside the narrows, an impure chloritic schist is found holding many small bands of dolomite and also veins of that mineral crossing the foliation and then associated with quartz.

Massive greenstone-conglomerate containing many boulders of granite occupies the western shore of McKenzie bay and forms the hills in rear, to Conglomerate point. For a mile beyond that place conglomerate and green schists are found; they are followed by a very hard green schist together with fine-grained siliceous dolomite and a dark bluish siliceous rock. These rocks contain disseminated pyrites. They continue along the shore to within a mile of the western end of the bay, where they are succeeded by an impure serpentine holding in places, thin veins of asbestus.

The valley leading from the west end of the bay to the foot of Juggler House is thickly wooded, and rock is only seen on the shore of a pond about a mile from the head of the bay; there it is a diabase schist. Similar schists occur on the summit of the mountain. About a mile to the north of Juggler House is a somewhat higher hill called Cuming mountain, with a much decomposed olivine-gabbro on its side, while it is reported that excellent asbestus has been discovered in the light-green serpentine at its summit. To the south of Juggler's is another similar hill somewhat lower than Cuming but so wooded that no examination of its rock has been made as yet.

No rock in place is seen on the north shore of McKenzie bay from its west end until near the Magnetic cone, a hill less than 100 feet high, close to the edge of the lake and opposite the west of Asbestus island. This hill possesses the property of attracting the magnetic needle at any place within a radius of half a mile from it. It is formed of dark-coloured serpentine containing a few small veins of coarse asbestus; spots of decomposed black rock upon the hill contain small quantities of magnetite in grains, but the amount of ore is quite insignificant. While attempting to find iron in this locality Mr. McKenzie accidently discovered the asbestus vein on the adjoining island.

Beyond the Magnetic cone the rocks form low outcrops at intervals along the north shore of the bay; these are all serpentine, usually dark-green to nearly black in colour; in a number of places they contain many small veins of asbestus. Asbestus island is high and rocky; it lies close to the north shore in the western part of the bay, and is about a mile long by half a mile wide. A number of shallow pits have been opened along its south side; these show a dark-green and brownish serpentine, cut by a network of asbestus veins. The rock on the north side of the island is of a darker colour, is harder and does not contain many veins of asbestus. A fuller description of these rocks is given later in this report under the heading Economic Minerals.

The serpentine rocks continue for nearly two miles along the north shore of the bay to the point leading out of Rapid bay. The northern shore of this bay is boulder-strewn, the solid rock being only seen near its head, where the exposures show conglomerate, a light coloured talcose schist, some impure serpentine and a coarse arkose cut by quartz stringers. Outcrops of conglomerate and pinkish arkose are found along the south side of Rapid bay; they increase in number towards the point separating it from the second eastern bay. Several rocky inlets lie off this point, where greenstone schists and red arkose are seen banded together, the arkose bands being from half an inch to three inches in width, the schist bands much wider. A number of small quartz veins cutting these rocks show copper stains.

One exposure of an impure serpentine occurs on the north side of

the second bay near its head, but the opposite shore is high and rocky, being backed by steep hills, and gives an almost continuous exposure of rock from its head to the narrows leading to the main body of the lake. A dark serpentine, sometimes associated with green schists, is found throughout.

The rocks are discoloured on the surface and often covered with vegetable matter so that it is difficult to distinguish between them. Dark, impure serpentine prevails and, in several places close to the water, was seen to hold veins of asbestus. Serpentine has been reported as occurring some miles to the eastward on Rapid river, where the water was too low last season to ascend with canoes.

On the south side of the narrows leading to McKenzie bay, dark green schists prevail and are found in frequent exposures to the foot of Sorcerer mountain, a high hill which crowns the point separating the northern bay from Island bay. These rocks are usually foliated and much decomposed to chlorite and epidote. When massive they sometimes show a fine-grained diabase structure. Small gash veins of quartz and calcite are numerous in them.

No rocks are seen along the northern foot of Sorcerer mountain, but on the face of the hill the colour of the rocks shows that they are probably a light coloured gabbro similar to that found at the west end of Malek island which lies close to the end of the point. This gabbro was originally composed almost wholly of white feldspar with little bisilicates. The rock was very coarse in texture and is now almost completely changed to the secondary minerals, talc, sericite, zoisite and saussurite. In places it has been crushed and foliated to an impure talc-schist.

Following the irregular eastern shore of Island bay numerous exposures of gabbro are seen on its islands and rocky points. The gabbro on the southwest side of Sorcerer mountain becomes finer in texture and in places contains considerable bisilicates, all more or less decomposed. Small segregations and veins of titanic iron ore are occasionally found, all too small to be of value; while the darker varieties of the gabbro hold small quantities of disseminated pyrite. At several places in this neighbourhood the gabbro appears to inclose bands of the dark diabase schist as well as small masses of impure serpentine. These rocks occupy the southeast part of the bay and its southern shore to the point of the smaller bays on that side; they also form the many islands dotting the surface of the bay. At the point mentioned the gabbro becomes gneissic and, a little farther south, is associated with the dark-red granite-gneiss. Similar contacts occur along the shores of the southern coves.

It would appear from a study of a number of these contacts between the granite and the gabbro that the former is intruded into the latter. Near the contacts the gabbro has been greatly crushed so that it is usually in the form of a fine-grained basic-gneiss due to the rearrangement of its bisilicate constituents. In places—at the

contacts or where masses of the gabbro are inclosed in the granite-gneiss it has the constituents of a protogene-gneiss due to the alteration and hydration of its bisilicates and to the presence of small quantities of quartz. The granite along the contacts usually has a gneissic structure. In its normal condition it appears to have been a pink mica-hornblende-granite, with ordinary quantities of quartz. Near the contact with the gabbro it is much darker in colour, the feldspar being a dark red and the hornblende being more plentiful and dark-green. The quartz is less than in the normal rock and all the evidence points to a large accession of basic matter from the digestion of portions of the gabbro by the granite at the contacts of the two. The geology here is further complicated by the presence of dark-green hornblendic rocks, much crumpled and squeezed and evidently older than both the gabbro and the granite. These are perhaps the equivalent of the diabase schist of the opposite side of the lake. If so, they have been subjected to a much greater alteration, being recrystallized to hornblende-schist.

On the east side of the small southern bay inside the south entrance to Island bay there is a peculiar green dike-like rock containing green crystals of hornblende.

Examined microscopically by Dr. G. A. Young this rock shows in a thin section very abundant stout phenocrysts of hornblende lying in a fine-grained base seemingly composed of idiomorphic plagioclase with allotrimorphic hornblende. About the southern side of the mouth of Island bay, and on the islands of that part, gabbro-gneisses containing varying quantities of bisilicates prevail.

Passing southward along the east shore of the lake from Island bay, the gabbro-gneiss alone is seen for the first five miles, after which the shore follows a contact zone between the gabbro and the granite-gneisses. In the small bays at the south end and to the east of the entrance of the portage route from Obatogamau lake the gabbro-gneiss is associated with banded masses of chlorite-schist; in these circumstances, the gabbro is usually changed to a soft talcose rock. The granite-gneiss at the end of the lake often contains decomposed bisilicates and thus forms protogene-gneiss. In several places narrow gash veins of quartz cut the darker rock; these usually hold a small quantity of pyrite but they are so small and irregular that they are of no practical value.

The chain of islands in the middle of the main body of the lake is formed of light-coloured gabbro in the northern half, where this rock is sometimes associated with bands of green schist. In the southern half a medium to fine-grained light-gray to pink mica-hornblende-granite, usually poor in quartz, is the prevailing rock.

Doré Lake.

Doré lake lies close to and parallel with Chibougamau. The north end is connected with Portage bay by a short rapid. Along

the shores of the two small bays forming the northern end numerous exposures of green schists are seen. These are usually dark in colour and contain much chlorite; in places they are hard and hornblendic and in other localities they are banded light and dark-green. Small veins of quartz often containing a little pyrite are common.

At the mouth of the small bays, and along the western shore, the green schists give place in part to light-pink, talcose schist which appears to be the squeezed equivalent of the arkose of McKenzie bay and of Paint mountain. These and their associated green schists carry considerable quantities of pyrite and some magnetite, both scattered through the rocks and in small veins. Rusty-weathering dolomite in narrow bands is associated with the schists. The bands are not continuous and appear to have originally been small masses, probably of secondary origin, which filled ancient cracks, and whose present character was assumed when the pressure caused the foliation of the schists.

The pink schist continues along the shore for a quarter of a mile when it gives place to soft green schists inclosing many narrow bands of rusty-weathering dolomite and often holding small masses of magnetite. Similar rocks are met with along the western shore for two miles to an irregular point beyond which the lake broadens. At this point the green schist is in contact with a light-coloured gabbro which in places contains considerable quantities of bisilicates and which incloses lenticular masses of the darker schist.

Beyond the point the prevailing rock of the west shore is gabbro, which in some places holds inclusions of the schist. In a few localities the gabbro has been rendered gneissic by pressure and is then decomposed to a schistose talc rock. The schists, when near the gabbro, appear to be rich in sulphides of iron and copper, but no mass of ore sufficient in size or richness to be considered workable was seen. The gabbro, itself, in places, contains some disseminated pyrite. The light coloured gabbro rocks continue along the west side of the lake for four miles or to within two miles and a half of its south end. For the remaining distance the rocks are largely gabbro mixed with light-gray mica-gneiss and, near the discharge of the lake, with some broken bands of green hornblende schist. Pyrite was frequently seen in the schist near the contacts. Some large quartz veins were observed on small islands near the middle of the lake, and these contained small masses of copper pyrites.

The eastern side of the lake, following it from its north end first, shows dark-green schists on the shores of the bay where the southern discharge from Chibougamau enters. Where the band of schistose arkose should be seen, the shore is low, so that its presence can only be located by joining the Paint mountain outcrop with that on the west side of the lake. Along the high banks extending two miles and a half from the southern inlet bay to a small point opposite the irregular point of the other shore, the rocks are chiefly dark-green schist,

sometimes with narrow bands of rusty dolomite, and containing varying small quantities of sulphides. In the southern part of this distance, tongues of light-coloured gabbro are found cutting the schist and, finally, a short distance beyond the point, only gabbro is met with. This rock is found on the eastern shore and islands for the next three miles southward, when it gives place to a basic hornblende mica-granite, pinkish or light-gray in colour, and often with its bisilicates decomposed to sericite.

The granite in the southern part of the lake is in contact with both dark diorite-schist and light-coloured gabbro and appears to cut both. At a number of these contacts the granite was quite basic, being for a few feet away from the junction, rich in bisilicates and poor in quartz. A number of quartz-pegmatite veins cut these rocks and in places hold cubes of pyrite, but are nowhere rich in sulphides.

Portage Route between Chibougamau and Wakonichi Lakes.

The portage leading from the west end of McKenzie bay of Chibougamau lake to the southwest bay of Wakonichi lake first passes up hill for about a mile to a small narrow lake. The forest on the hillside has been destroyed by fire and allows several small outcrops of rock to be seen. These are dark-coloured diabase usually showing foliation, and cut by a few narrow stringers of quartz too small to be of value even if rich in mineral—which they are not.

The country about the first two lakes is flat and swampy, with only a few knolls of schistose diabase rising above the level of the water. More broken country surrounds the last small lake before reaching Wakonichi, and the many rock exposures there show a fine-grained diabase usually schistose and, in several places, cut by small stringers of quartz containing little or no pyrite.

Wakonichi Lake.

The portage route from Chibougamau reaches Wakonichi near the head of its southwest bay. Following the south shore from the portage into the southeast bay, moderately high banks of drift are passed, with no exposures of rock until that bay is entered. Then, ledges of light-green fine-grained felsitic schist occur at intervals along the shore, sometimes holding small gashes of barren quartz. At the mouth of the southern arm of the bay, and along its south side, are several exposures of a grayish-green rock, medium to fine-grained in texture, holding fragments and pebbles of dark slate. In thin section this rock is seen to be much decomposed and is made up largely of angular plagioclase sometimes slightly rounded with a few grains of rounded quartz. These grains are usually crowded together without any embedding material. The rock appears to have been derived from one largely composed of plagioclase feldspar.

At the mouth of the stream entering at the head of this arm green schist is found cut by small dikes of red granite. Numerous exposures of light and dark-banded chloritic and felsitic schists occur on the shores and islands of the north arm.

About half a mile beyond the point separating the southeast bay from the main body of the lake there is an exposure of light-green chloritic schist interbanded with talcose schist and cut by a few gash veins of pinkish quartz holding dark-green hornblende. This exposure continues for a quarter of a mile, the rocks being greatly disturbed and shattered in the northern part. A small exposure of dark green schist containing angular fragments or broken bands of red granite is seen two miles farther north on this east side of the lake.

The next outcrop is on an islet close to the shore, a mile north of the last. The rock here is a dark-green to black, rusty-weathering schist containing considerable quantities of pyrite scattered through the schists, evidently in the form of secondary segregations. Some light-coloured schists are associated with these darker ones. Under the microscope the rock apart from the numerous quartz veins is composed of exceedingly fine-grained quartz or perhaps chalcedony so impregnated with graphite that the rock appears black and perfectly opaque.

Two small islands that lie about three-quarters of a mile off this place are formed of conglomerate having a thickness of two hundred feet. There are partings of green schist in the conglomerate and that rock forms the matrix in which granite pebbles and boulders up to several feet in diameter are thickly strewn. Some of the pebbles and boulders are only partly rounded and appear to have been little water-worn. A medium-grained very feldspathic red granite is the material from which the greater number of these were formed, but there are also pebbles of lighter coloured granite, light-green diabase and rounded masses of green diabase-schist. On the western side of the larger island two large quartz veins occur in the conglomerate close to the water. They contain small quantities of pyrite, but an assay of a sample brought home gave only a slight trace of gold.

Returning to the east shore of the lake, about a mile and a half north of the pyritiferous schist already mentioned, there is a small exposure of conglomerate containing more angular fragments of granite than does the conglomerate on the islands. Beyond this, no rock in place is seen along the eastern shore for upwards of five miles, or to a mile within the limits of the northeast bay. The shores along this interval are formed of tightly packed boulders, most of which are granite, together with limestone and cherty dolomite from Mistassini, black quartzite, lean banded jaspilite, conglomerate and the darker basic rocks of the region.

After this long interval there is a low cliff consisting, at the bottom, of recomposed medium-grained dark-red hornblende-granite

which passes gradually upwards into a finer-grained dark-red arkose slate. Under the microscope this rock is seen to be composed of angular or slightly rounded grains of quartz, microcline and plagioclase embedded in a ground of the same minerals in a much finer state and with much sericite. The feldspar grains are sometimes much decomposed, but more often quite fresh. The rock or rocks from which the arkose was derived evidently had been subjected to great strain. The arkose contains abundant magnetite, and the red colour appears to be due to the oxidation of part of the iron ore. In the upper part of the cliff the red arkose is banded with green schist. The same red arkose-slate occurs in a small bay half a mile further north, while, at the head of the bay medium to fine-grained dark-red recomposed granite is again seen passing upward into red arkose.

On the west side of the bay is a steep hill 300 feet high whose cliff facing the bay gave, at the bottom, dark-red granite passing imperceptibly through re-arranged granite into a red arkose, which, in thin section differs only from that last described in containing coarser fragments. Above this is a dark-coloured quartzite splotched with small brown spots, while on top is a coarse conglomerate of granite boulders and pebbles in a green schist matrix. In places, on the top of the hill, the boulders are rare and the rock then closely resembles the dark-green diabase-schist of Chibougamau and elsewhere.

The cliff was faced with much angular debris and the surface of the rocks was hidden beneath several inches of moss, so that no accurate measurements of the section could be obtained.

On a small island two miles and a half from the head of the bay there are good exposures of red and green arkose both somewhat schistose and apparently nearly flat-bedded, with minor crumplings. In several of the beds granite boulders were seen either singly or in groups.

On the small points for a mile within the end of Specular point several exposures of a medium to fine-grained light-pink granite-gneiss were seen, together with masses of green diabase-schist, the granite apparently penetrating and inclosing masses of the schist. This granite differs in colour and appearance from the dark-red granite from which the arkose was derived and which, in consequence, is older than the green schist forming the matrix of the conglomerate.

At Secular point the conglomerate is again met with, and it has apparently been much shattered by the intrusion of the newer light-coloured granite seen in the islands close by. The conglomerate has been intensely fractured and is now cut by a network of small veins usually filled with quartz and scales of specular iron ore, but sometimes with the latter only. This fractured conglomerate is continuously exposed along the edge of the water for upwards of half a mile at the point.

A short interval of drift-covered shore separates it from the light coloured granite on the shores and islands leading into the north west bay. This granite varies in texture from fine to medium grained; is of a light-pink or white colour and is composed largely of light-pink feldspar, black hornblende and biotite with little quartz. It rarely exhibits a gneissic structure. All the rocks seen on the island and shores of the northwest bay are granite; granite also forms the prominent hill on the west side of the lake and continues along that side for seven miles from the head of the bay to near the north end of a large island close to that side.

An interval of a mile of low shore separates the last granite exposure from the next outcrop of dark-green diabase-schist which is cut by small short veins of quartz. From here to the portage leading to Chibougamau in the southwest bay only dark-green diabase, diabase-schist and conglomerate are seen. These rocks rise in abrupt cliffs from fifty to two hundred and fifty feet high in many places along the west side of the lake. The diabase and the conglomerate often appear not to have been subjected to much pressure; consequently they are unfoliated and their thick beds seem to be thrown into shallow domes with gentle dips. The diabase is greatly decomposed in most places and its original structure is generally obscure, but in many patches where decomposition has not been great the diabase-structure is distinct and, in some localities, the rock is porphyritic and contains large crystals of white plagioclase.

The position of the conglomerate bands is often most peculiar; frequently, they appear to be suspended in the mass of the diabase, having that rock both above and below; in other places, single boulders of granite are seen in the diabase far away from any of their fellows. The diabase was either a sill or outflow, and solidified in a nearly horizontal position. The molten rock must have flowed both over and under the boulders of the conglomerate, or else they must have risen or sunk in the fluid mass by difference of specific gravity; this would account for the isolated granite boulders. Quartz veins and gashes are common in these rocks but samples from the largest and most promising yield no gold on assay and never appear to carry sufficient sulphides to make them of value.

Wakonichi Lake to Mistassini Lake.

The small river flowing north from Wakonichi passes from the head of the northeast bay by a short stretch of swift water through a narrow channel greatly obstructed with large blocks of arkose. A small lake expansion then leads north for half a mile to another contraction, where the river falls thirty feet in about three hundred yards. The portage is on the east side and along its northern half are a number of rocky hummocks deeply covered with moss. There appears to be a contact here between dark-red granite and a dark-

to coarse gray grit. Large crystals of the granite seem to be embedded in the grit. The latter, on thin section, is found to consist of rounded water-worn individuals of quartz and occasional plagioclase lying in a base of angular and subangular grains of quartz and feldspar with dense turbid ground. Here and there occasional composite fragments occur. Through the base are many minute grains of zoisite, the coloration of which probably has caused the rock to assume its red colour.

On the west bank, a short distance below the portage, there is an exposure of coarse red mica-granite containing small thin partings of copper oxides, this rock is associated with a light bluish grey wacke which, under the microscope, shows small, partly rounded or angular grains of quartz, microcline and plagioclase in a very fine grained base of the same minerals and with minute scales, chlorite and biotite in irregular shreds and flakes. In the hand specimen this fine grained rock contains nearly angular fragments of feldspar, so that at first sight it resembles a porphyry.

Below the portage the river widens into a lake expanse and continues so for three miles. At the head on the west side, a mile below the portage, another exposure of brownish grey greywacke occurs. It is very much shattered, the small cracks being filled with rusty-weathering dolomite. In thin section the rock shows a detrital origin and is composed of more or less larger water-worn grains of quartz lying in a fine-grained aggregate of rounded to angular grains of quartz, alkali feldspar and plagioclase with a small and variable amount of turbid base.

At the lower end of the lake expansion the river contracts and flows swiftly for a mile to where it falls into the southern end of Lake Mistassini. Two short rapids entail a portage in ascending this portion of the river. In the river bed at these rapids ledges of cherty limestone in a somewhat disturbed condition are seen. These limestones, which are found in the great basin of the Mistassini lakes, are of Upper Devonian age and appear to rest unconformably upon the Lower Huronian rocks just described. Several small islands in the southern bay of Mistassini, not far from the inlet, are formed of these limestones lying almost horizontally.

Chibougamau River.

The Chibougamau river flows out of the south end of Doré lake the geology of which has been already described. From the outlet the course is straight southwest for three miles to where it falls with strong rapids into its first lake expansion. A few small exposures of gray and pink mica-granite, similar in character to that of the southern part of Doré lake, are seen along this stretch. Of the islands at the head of the lake expansion green schists occur mixed with a basic granite. No other rock was seen to the south end of the bay

where there is a long outcrop of dark green schist holding a few thin bands of granite conglomerate resembling those of Chibougamau and Wakonichi. These rocks are cut by a few small veins of quartz.

Rock in place was not again seen until a small south bay was reached immediately above the rapid leading from the first to the second lake expansion, where green schist was found mixed with broken bands of basic granite. A contact between a light-gray medium grained protogene-gneiss and the dark diabase schist occurs along the river-stretch joining the second expansion with David lake. Further on, the contact is between a light greenish medium-grained gabbro and the dark schist. On the northern islands and shores of David lake light coloured gabbros prevail and they hold bands and masses of green schists, these latter in some places contain considerable quantities of disseminated pyrite. In many places near the contact the gabbro appears to have absorbed fragments from the schist.

On the river connecting David and Simon lakes several exposures of coarse light coloured gabbro are seen holding darker patches of finer texture and containing more hornblende. These are either inclosed masses of the diabase or basic segregations in the gabbro.

The rocks along the eastern side of Simon lake are gabbro and diorite; in the northeast corner they are further complicated by green schist. On the west side of the lake the green schists are cut by dikes of a light gray fine-grained quartzose mica-gneiss. Passing southward along the west shore the green schist becomes less common and the rocks are largely made by a greenish protogene gneiss with fine-grained dark-coloured diorite-gneiss and hornblende schist.

Along the river and on the east shore of Asinitchibastat lake, south of the inlet, granite gneisses prevail and often hold broken bands of chlorite and hornblende schists. With the exception of a small granite area opposite the entrance of the river, the western shore of the lake shows an almost continuous exposure of diabase and diabase schist. It is usually schistose but in many places it has not been sufficiently foliated to lose its original structure and in these cases, shows that it lies almost horizontal, while the schistose portions appear to be on end. To the north of the small area of granite already mentioned, there is a narrow band of light greenish brown, calcose schist containing considerable quartz and marked by rusty patches, so that it resembles the squeezed arkose of Chibougamau.

The hard green schists are most prevalent as far as the northern bend of the lake and, in several places, inclose short narrow bands of rusty-weathering dolomite like that already described in similar schists at the north end of Doré lake. Northward from the bend to the north end of the lake, and for about four miles down the river, many exposures of hard and soft green schists are seen. Frequently they are without foliation and are then a fine-grained diabase in a

[illegible]

[illegible] dant; it is often associated with rusty weathering dolomite stringers, while darker green and slightly coarser hornblende schist are less common. All of these rocks contain disseminated pyrite, [illegible] and never abundantly. Gash veins of quartz are frequently seen and, in a couple of places, are of considerable size, but they carry little or no sulphides and no gold. A [illegible] which may prove to be quartz, was seen from the lake on the flank of a high hill on the east side of the north [illegible] of the lake.

From the last exposure of diabase, four miles down the river [illegible] Asinitchibastat lake to the junction of the branch which heads [illegible] Wakonichi and from there to Rush lake, the river flows through [illegible] mp, with only one small outcrop of rock. This is at the foot of a small hill on the west side, about three miles below the last exposure of diabase; it is formed of medium-grained red, [illegible] granite.

Diabase rock is again met with along the western shore of Rush lake, where it forms low knolls rising above the flat swampy country, and is no doubt a western and northern extension of the diabase area of Asinitchibastat lake. The exposures seen on Rush lake and along the river connecting it with Little Rush lake are, as a rule, massive, light-green, fine-grained diabase, almost wholly decomposed to chlorite and in a few places badly fractured or schistose.

The islands and shores of Little Rush and Five-mile lakes are [illegible], the country becoming hilly towards the south end of the latter. The rocks are all fine-grained decomposed diabase very little disturbed and apparently lying in low domes with nearly horizontal bedding. These exposures show very small gashes of quartz, and economic minerals appear to be rare.

The diabase is continued to Opemiska lake, where it is seen on the north shore in its eastern half while, in the western part, it only reaches the heads of the longest bays. The remainder of the lake basin has been hollowed out of an area of pink to red, medium to coarse-grained, very feldspathic granite whose original bisilicates hornblende and biotite are largely decomposed to chlorite.

The granite area continues to beyond the western end of Mikwasach lake and is probably connected with similar granite found along the Obatogaman river for a few miles above its junction with the Chibougamau. The northern edge of the granite runs close to the north shores of Opemiska and Mikwasach lakes, where it is in contact with a violet anorthosite rock. On a small island in the northeast part of Mikwasach, and not far from the granite contact, the rock is a coarse-grained mica-gabbro. Under the microscope this rock is seen to be composed essentially of augite, biotite and plagioclase feldspar with accessory apatite and iron ore, both of the

last being in small amounts. The abundant coloured constituents compose about two-thirds of the thin section. The augite is of a pale, greenish-gray colour and forms large and small individuals quite irregular in outline. The deeply pleochroic brown biotite is less abundant than the pyroxene; it occurs in shapeless plates, often partly inclosing individuals of augite or feldspar. The plagioclase appears to be andesine; it tends to form lath-like individuals usually much smaller than those of the coloured bisilicates and towards which the feldspar is often idiomorphic.

At the discharge of the lake a very hornblendic red granite cuts the mica-gabbro and appears to have absorbed considerable hornblende from the latter. A short distance down the stream the gabbro predominates and is cut by small dikes of basic granite. Away from the contact, the gabbro changes to a dark violet anorthosite, composed largely of coarse plagioclase with many irregular spots of dark green saussurite. In many places the feldspar is light in colour and is mixed with considerable quantities of augite, forming a coarse gabbro. This basic mass forms a high hill to the east of the river and has a breadth of nearly three miles where the stream breaks through the western flank with heavy falls and rapids. On the north side of this mass at the foot of the portage past the falls it is a coarse gabbro and is followed by fine-grained green decomposed diabase a short distance below the portage, an evident western extension of the diabase rocks from the upper river.

The diabase at the next portage has been squeezed into schists, and similar schist is seen at the end of the portage leading to Brock river. Massive and schistose diabase are again met with on the banks of the river three and five miles below the junction of the branches where they appear to be penetrated by small dikes of coarse gabbro. A mile below the second outcrop there is a long low cliff on the north bank formed from a soft dark green chloritic rock which weathers to a greenish white on the surface, and has been deeply sculptured by the water. This schist is remarkable owing to the secondary crystals of dark brown diopside developed in it. The crystals range to an inch in diameter and weather out perfectly on the surface of the soft schist.

Similar schist is seen on the same side of the river a mile below the end of the first exposure with the porphyritic crystals of pyroxene developed in patches. Again, after an interval of two miles, these soft schists outcrop but are there free of pyroxene crystals. Three miles farther down stream, at the sharp bend to the north, there are a number of outcrops of massive decomposed diabase having here and there a slight foliation. These are followed after an interval of two miles by the light-green soft chloritic schists; while at and below the rapids from the last exposure low outcrops of schistose diabase occur on the banks and in the bed of the river.

No rock in place is then seen for five miles, after which there is

an almost continuous succession of rock exposures to the junction of the Obatogamau river, four miles farther down stream. The rocks along this stretch are mostly schists formed from decomposed diabase; the greater part are light green, fine-grained, feldspathic and chloritic, and are moderately hard. Other bands are softer and contain sericite and sometimes mica. No large quartz veins, nor any indications of valuable minerals, were observed in the rocks along the river below Mikwasach lake.

Obatogamau River.

The Obatogamau river, from the outlet of Presqu'ile lake to its junction with the Chibougamau river, flows through a low, flat country and the only rocks seen along its course were found at the rapids, where the river passes between low ridges of hummocky hills.

The first exposure is about a mile above its junction with the Chibougamau river, where a contact between the diabase-schists and a probable western extension of the Mikwasach granite occurs. Above this, a number of small outcrops of granite were seen in the rapids to the swampy country about the Sturgeon lakes. Then, for a distance of six miles directly eastward—and much farther by the crooked river—no rock outcrops until the next rapid is reached, when diabase and diabase-schist are found in the bed of the river for a mile or more.

Above these rapids the river again assumes a sluggish character, with low banks of mud, and flows in this manner for ten miles from the next rapid where the stream in ascending bends sharply from south to east.

Here, typical Laurentian, very quartzose, pink and gray gneisses were found. Similar gneisses, sometimes associated with bands of more basic, darker gneisses occur at rare intervals in the next nine miles directly east. In the following five miles eastward there is a predominance of the basic diorite-gneiss over the lighter-coloured granite varieties and it is supposed that there has been an intimate association of the two; the darker rocks representing an ancient diabase penetrated by the lighter coloured granite. Subsequent pressure and heat caused schistosity and mineral alteration in both. There is no evidence to show that these rocks are not a more highly altered phase of the granite and diabase of other parts of the region but, owing to their highly altered condition, they have been taken to be older.

About two miles below Presqu'ile lake there is a change in the rocks to a medium-grained, light-gray, biotite-granite, very similar in character and colour to the granite of the western part of Obatogamau lake. The same granite is found at the outlet of Presqu'ile lake. A contact between the granite and dark-green diabase and porphyry rocks occurs along the southern shores of the lake with the granite in the northwest bay and the diabase and schists forming the islands and rocky shores of the east side. The porphyry was only seen as a wide

band or dike in the granite on the south shore at the first point beyond the discharge. It contains crystals of white feldspar up to an inch in length embedded in a dark fine-grained ground mass.

A few exposures of schistose diabase are seen along the lake expansions of the river between Presqu'ile and Eau Jaune lakes. The last mentioned lake is filled with rocky islands and broken into irregular bays by low rocky points. The rocks, with the exception of those in the extreme southern part of the lake, are all diabase or diabase-schist, usually a hard chloritic variety of the latter with occasional masses having a talcose character. Disseminated pyrites in small quantities cause some of the schist to weather rusty but nowhere was the mineral found in sufficient quantities to be of value. A few small barren gashes of quartz were seen in a number of places.

The granite of the southern portion of the lake is a fine-grained, light-gray biotite-granite probably of the same age as that of Presqu'ile lake.

The dark green rocks continue to the narrows leading to Mukwasho lake after which the shores are formed of gravel and sand to beyond the southern bend of the lake where a medium-grained, pink to red hornblende-granite is found on both the shores and islands. There is a change in the physical character of the country surrounding the lake, which leads to the belief that the granite probably extends westward to where the dark schists were last seen at the narrows mentioned above. This granite is quite distinct from the light-gray biotite variety of the last two lakes, and it bears a close resemblance to the hornblende-granite of Opemiska lake.

The granite is again replaced by diabase-schist where Mukwasha lake bends east and contracts to the lake expansions joining it with Obatogamau lake. Numerous exposures are seen in this section, all of the same character; they form a western extension of the wide area of diabase rocks which have already been described as occurring in the western part of Obatogamau lake.

ECONOMIC MINERALS.

The discovery of an area of serpentine rocks containing asbestus very similar in character and quality to that so extensively mined at Thetford and Black lake, together with the finding of a large reef of gold-bearing quartz, and numerous indications of copper ores, has caused considerable interest to be taken in the mining possibilities of the Chibougamau region.

The asbestus was first accidentally discovered, during the summer of 1903, by Mr. Peter McKenzie on Asbestus island in McKenzie bay of Chibougamau lake while searching for iron ore in that locality. The specimens brought by him to Quebec were of such an excellent character that in the following summer Mr. J. Obalski, Inspector of mines for the province of Quebec, visited the locality in company

with Mr. McKenzie and on his return reported very favourably upon the mining possibilities of the region. During the visit of Mr. Obalski to Chibougamau a large reef of gold-bearing quartz was discovered on Paint Mountain island, where indications of copper were also found, and in several places about the lakes signs of iron were seen.

On the strength of these discoveries, The Chibugamoo Mining Company, Limited, was formed to develop the discoveries of Mr. McKenzie and, on behalf of this company Mr. Hardman made, in the early part of the summer of 1905, an examination of the asbestus, gold and copper deposits, while Mr. W. W. J. Croze represented the United States Steel Company in regard to the iron ores.*

As already stated, a petition from prominent citizens of Quebec was sent in the spring of 1905 to the Right Hon. Sir Wilfrid Laurier, asking that a member of the staff of the Geological Survey be sent to this region, and the writer was selected for this duty.

During the summer of 1905, the Chibugamoo Mining Company had a small force of men engaged in opening and proving the asbestus deposits of Asbestus island, and the quartz reef and copper veins of Paint Mountain island. At the same time a few parties of prospectors were examining the region between Obatogamau and Mistassini lakes. A number of prospecting licenses have been taken out by them from the Quebec Government for mineral claims in this region.

As may be seen from the geological description, the Chibougamau region is underlain chiefly by igneous rocks, and the deposits of economic minerals appear to be largely confined to one class of these, that is, to the diabase and to its alteration products—green schists and serpentine—together with its associated conglomerates and arkose, all of probable Lower Huronian age.

The large masses of newer gabbro and granite are not, in themselves, well mineralized but they both appear to have been important factors in the deposition and concentration of ores in the diabase and diabase-schists, which they cut. In this respect the gabbro appears to have been the more active and it is in the neighbourhood of contacts between it and the diabase that the greatest quantity of sulphides of iron and copper were noted. In all probability, therefore, any large deposits of these minerals will be found in proximity to such contacts and attention may be drawn to the contacts between these rocks in the region stretching westward from the northeastern part of Chibougamau lake across to Asinitchibastat lake and also to the contacts of the diabase with the gabbro on the north side of Opemiska and Mikwasach lakes.

Asbestus has been found in all the areas of serpentine discovered to date and there is little doubt extensions of these areas will be found both to the east and the west of their known occurrences about McKenzie bay.

* Report to the Chibugamoo Mining Company, Limited, John E. Hardman, S.B., Ma. E.

The association of conglomerate and arkose beds with diabase and similar volcanic rocks bears a close resemblance to the occurrence of these rocks in the area about Timiskaming lake, where the small rich veins of silver, nickel and cobalt have been found. Up to the present time, no such deposits have been located in the Chibougamau region but characteristic small veins of specular iron ore occur in these rocks, as well as small quantities of copper. The silver and associated ores of Cobalt are perhaps unique, and are probably due to certain conditions of which we at present lack all knowledge. These unknown conditions may exist at places in the wide area of conglomerate rocks about Wakonichi lake but this can only be determined by close prospecting for the small but rich veins. It is thought well to call attention to the presence of these rocks about the northeast bay of Wakonichi, and also along and extending westward from its southwest shores, as well as on the islands and part of the shores of McKenzie bay and Paint Mountain island of Chibougamau lake, where they extend westward across the northern part of Doré lake. A small area also occurs at the south end of the first lake expansion of the Chibougamau river, below Doré lake.

The large masses of diabase and diabase schists, away from their contact with the gabbro and granite, do not appear to carry large quantities of sulphides, nor have these ever been found sufficiently concentrated to make workable deposits; thus, it would appear that little attention need be paid to prospecting them.

Throughout the region small quartz stringers and gash veins are numerous in the dark-green rocks but, as a rule, they hold very small quantities of sulphides, and samples from several of the larger veins gave, when assayed, only faint traces of gold.

The above short notes are given to indicate to the prospector the most promising localities in the region in which to search for minerals.

Gold.—The only ledge of gold-bearing quartz known to the writer is situated on the southeast side of Paint Mountain island. The vein is seen near the summit of the hill at an elevation of 130 feet above the water of Chibougamau lake and a few hundred yards from the shore. It occurs in a dark-green diabase-schist which, along the shore of the lake, is cut by many irregular dikes or tongues of lighter-coloured, coarser-grained gabbro and it is probably due to this penetration of the schists by the gabbro that the vein is mineralized with copper and gold.

The quartz has a large outcrop at the discovery point and smaller ones a short distance to the east and west of it. Openings along the vein, extending for 400 feet to the west of the large outcrop show that it runs nearly east-and-west and that it is parallel to the foliation of the surrounding green schists.

A cut about six feet deep made across the vein where it was first seen gives a width of thirty-seven feet to the larger mass which

is separated by twenty-five feet of schist on the south from a second mass eight feet wide. Both are nearly vertical or dip at a high angle to the south. At a second cut, 165 feet west of the first, the main mass has a width of forty-three feet, but the second vein was not uncovered. The third opening, 400 feet west of the first, is through a considerable thickness of glacial drift with about a foot of ancient yellow soil between it and the rotted rock below. This cut has been carried only a short distance into the rotted rock, part of which is broken quartz and part rotten schist; the imperfect showing appears to indicate that the quartz vein was breaking into several stringers separated from one another by partitions of schist. In all, the length of the vein has been proved for about 500 feet, and there is little doubt that it will be found to have a considerable extension eastward, unless cut off by a fault.

The position of the vein in and parallel with the foliation of the schist points to this quartz mass being a large lens rather than a true fissure vein; but, even as such, with its great size, it must contain many hundred thousands of tons of quartz. A number of quartz boulders are scattered along the hillside and down to the edge of the lake to the southwest of the outcrops on the hill. One of these large boulders on the shore of the lake contains free gold, and led to the discovery of the ledge. Both Mr. Obalski and Mr. Hardman are of the opinion that this string of boulders has descended by gravity from an extension westward of the quartz ledge in rear, while the writer believes that the boulders have been moved to their present position by glacial ice from their original position near the large outcrop of quartz.

The vein is largely quartz with considerable quantities of iron and copper pyrites scattered through the mass, sometimes in fairly large bunches; these, towards the surface, have been partly decomposed to oxides. The gold is found both free and in combination with the sulphides of iron and copper, so that for its total extraction the cyanide process will be required.

Mr. Hardman took many samples from the outcrops and cuts and in his report on them says: "The average of all these samples in free gold reached the sum of $2.50 per ton, including a number of samples (seven in number) which gave no trace of gold. Separating the samples which were taken from the big or forty feet vein, from those which came from other places, the average result in free gold is $3.14 per ton; an amount, I must say, which was very gratifying and very surprising to me, also. As showing, however, the extreme variation in the amount of free gold in the samples, I may say that the smallest amount of free gold which I obtained was forty cents to the ton of rock, whereas the largest was $11.48 to the ton. In this connexion it is worthy of note that the samples from cut B were of very much higher tenor than those from cut A or cut C. The richest sample obtained, namely: that of $11.48 to the ton was from cut B,

as were also the next richest, namely: of $8.61 and $8 per ton, and I, therefore, am of the opinion that the distribution of the gold is not uniform throughout the big vein, but that, as in other places, there are enrichments of this vein in places, and [illegible] appears to be one of these places.'

The fire assay apparatus which had been taken to Chibougamau became defective after a few tests, so Mr. Hardman was unable to treat his samples in this manner on the ground, but he concludes from other assays that the average fire assay value of the quartz is somewhere in the vicinity of $10 per ton.

The vein is advantageously situated for easy mining, while the necessary power for mining, hoisting, milling and other work might cheaply be developed at the fall of the southern outlet of Chibougamau where a plant capable of developing several hundred horse power could be installed at little expense, once the necessary machinery was landed there.

As has been already stated, a number of quartz veins throughout the region were sampled and they failed to give gold on assay, so that the occurrence in the quartz of Paint mountain is the only deposit of gold discovered at the present time in the region, but, as this mass of quartz is found in the green schists close to their contact with the gabbro, it may follow that other masses of quartz, similarly situated, will be discovered containing gold. The most promising localities for the discovery of such veins is along both sides of the mass of gabbro extending westward from Chibougamau lake almost to Asinitchibastat lake.

Copper.—No large nor important deposits of copper ore have been found in the region up to the present time, but in a number of places good signs of ore are to be seen and these may indicate the presence of valuable quantities of copper in their vicinity. Copper pyrites are most abundant in association with iron pyrites on Paint mountain, where they occur as small stringers, usually along the contacts between the green schist and the tongues of gabbro which penetrate the schist. Some exploratory work has been done on a few of these stringers but all have proved too small and disconnected to pay for working. Copper pyrites are also found in small quantities disseminated through the green schist and, more sparingly, through the gabbro here.

The schists of the northwest shore of Doré lake contain small stringers of quartz which, near the contact with the gabbro, hold small quantities of sulphides of iron and copper. Similar small quantities were also observed in the quartz stringers farther westward in the schists, near contacts. These wide-spread occurrences of small quantities of copper in the schists point to the possibility of larger deposits being found in favoured localities of the region to the westward of Doré lake.

Small, thin partings of copper pyrites, found in the arkose rock about the head of the northeast bay of Wakonichi lake and along its discharge into Mistassini lake, are recorded as indications of copper ore in that rock.

Lead and Zinc.—Masses of galena, associated with zinc blende, have been recently found in the Upper Huronian limestone at the narrows, a short distance from the Hudson's Bay Company's post on Mistassini lake. This occurrence was not visited by the writer and little information has been obtained as to the size and probable value of the deposit.

Iron.—No deposits of iron ore of size sufficient to render them of economic value have, up to the present, been discovered in the region under consideration. Some few prospecting claims have been taken up on small deposits of ore along the southwest side of Sorcerer mountain at Chibougamau lake, but the surface indications there show only small veins and segregation masses in the gabbro rocks, and iron ores occurring in such rocks are almost sure to contain titanium, and to be of little value.

The rotted serpentine of the Magnetic cone in the western part of McKenzie bay contains magnetite in disseminated grains, but the percentage of iron is much too low to make it of any value whatever. Small patches of magnetite are seen in the green schists about Chibougamau and Doré lakes as well as elsewhere but they are only important from a mineralogical point of view.

The conglomerate and arkose rocks about the northeast bay of Wakonichi lake contain many small veins of quartz and beautifully crystallized specular iron ore, and in places the ore occurs without the quartz. Where the arkose has been rendered schistose, as on the northwest side of Paint mountain, the specular iron ore is found as thin partings in the schist. The ores at all these localities are never sufficiently concentrated to allow of economical mining.

A number of large angular rocks of lean jaspilite, a mixture of bands of red jasper and magnetite-hematite ores, were seen mixed with the granite and other boulders which line the eastern shore of Wakonichi lake. These angular blocks have evidently not been transported far from their original site and they probably come from the rough country to the northeast between Wakonichi and Mistassini lakes where they in all likelihood form part of the Lower Huronian bedded series of rocks. This is the most promising indication of the presence of valuable iron ores in the region, but the deposits must be richer in iron than are the loose blocks, before they wi be of value as workable deposits of iron ore in the near future.

Asbestus.—Serpentine asociated with conglomerate, arkose and green schist is found on both sides of McKenzie bay. These rocks have been subject to strong pressure, perhaps due to the intrusion of the great gabbro mass to the west and south. No matter what the

cause of the pressure may be, all these rocks have been forced into long narrow bands, and most of them display a schistose structure parallel to the length of the bands or from east-northeast to west-southwest.

Dark green impure serpentine is found along the north shore of McKenzie bay from near its western end to within a short distance of the mouth of Rapid river, which flows into the head of its north-western cove. Bands of conglomerate, arkose and schist occupy the point dividing this from the next cove, and they are followed by a second band of serpentine which, with green schist, occupies the south-east side of the bay from the head of that cove to the narrows leading to the main lake. The western extension of the first or northern band crosses the head of the western end of McKenzie bay and occupies its southern shore for a mile or so to its head. Asbestus island, being in line between the outcrops on both shores, is also formed of serpentine belonging to this band. Owing to the thickly wooded country, with its surface deeply buried in moss, it is almost impossible to trace the bands beyond the shores of the bay and, up to the present, prospecting has been confined largely to the margin of the lake. Nothing is known of the western extension of this northern band except that it does not reach the shores of Doré lake.

As already stated, Juggler House is a sharp peak of schist about two miles beyond the western end of McKenzie bay. Cuming mountain lies about a mile to the north of it and a beautiful light-green serpentine, carrying excellent asbestus, has been reported as occurring in its summit; this serpentine probably forms a third band.

The eastern extension of the north band is lost in the low country on the north side of Rapid river, while the southern band is said to have been found crossing that stream some four or five miles to the northeast of McKenzie bay. To the west the southern band appears to end at the narrows. Areas of serpentine carrying asbestus are said to occur on the northern shores of Island bay, but they were not seen by the writer; if they are there they must be small inclusions in the gabbro rocks which occupy that portion of the basin of Chibougamau lake.

The above description of the serpentine rocks shows that at least two bands are known, each having a breadth of upwards of a mile and each extending at least five miles in length, with the probability that they will be found to extend considerably farther.

These serpentines are of economic importance owing to the veins of asbestus contained in them. Asbestus was first discovered on Asbestus island and at that place alone have attempts been made to prove its quality and quantity; in all other places, only the surface-weathered indications have been observed. Along the north side of the bay from Magnetic cone to near Rapid river the frequent outcrops of serpentine show in a number of places small reticulated veins of asbestus, none of which exceed half an inch across the vein.

Along the south shore veins up to an inch in width were seen in a number of places. The eastern extension of this band to Rapid river is also said to contain good asbestus while that discovered on Cuming mountain is probably the best in the region.

Asbestus island is about a mile long and about half that distance across in its widest part. The serpentine on the southern side is dark brownish green, while on the northern side of the island it is much darker in colour, harder than the green variety and contains only small narrow veins of asbestus.

The asbestus found on the island and elsewhere in the vicinity is very similar in appearance and in the mode of its occurrence, to that of the famous deposits at Thetford and Black Lake. As is well known the asbestus of these places is a fibrous variety of the serpentine called chrysotile, and occurs as the filling material of small cracks in the rocks. These cracks were probably formed by shrinkage of the mass and perhaps, in part, by the crushing action of the same pressure which lengthened and flattened the serpentine areas, and at the same time made the associated rocks schistose. The asbestus appears to the writer to have been deposited in the cracks under great pressure from superheated waters which, penetrating the rock, absorbed the material of the serpentine until the solution became a saturated one. With cooling, the mineral would be deposited in the cracks. The finely divided state of the mineral, and the direction of the fibres across the vein, point to its deposition under pressure. Where the veins are less than an inch in width the crystallization has begun upon one side of the crack and extended across to the other; in wider veins the mineral appears to have commenced formation on both sides of the crack so that there is a break in the continuation of the fibre near the centre of the vein where grains of iron ore and other impurities are often found between the two sets of fibre.

In the Thetford and Black Lake areas masses and dikes of granite have been intruded into the serpentine and these probably account for the necessary pressure and heated waters to form the asbestus there. In the Chibougamau region no such instrusion of granite has as yet been noted and the necessary heat pressure and thermal waters may have come from the large gabbro mass to the westward or from deep seated igneous masses not at present seen on the surface.

On the south side of Asbestus island six small openings have been made along the face of the hill into the serpentine rock; not one of these is more than a few feet deep, nor do any extend below the surface-weathering of the rock, so that no clear idea can yet be had of the quality of the fresh asbestus of the interior. These pits extend along the face of the hill for a distance of upwards of five hundred yards from the west point of the island and, in all of them, veins of asbestus have been uncovered. The first pit from the west end

of the island shows excellent silky fibre from a half to an inch and a half in length. In the second opening there are a number of small veins of good fibre and some wider ones where the fibre is not so fine, although it crushes well and would be valuable for boiler covering and other course uses. At the next two pits the serpentine is hard and is crossed by a number of small dikes composed chiefly of white pyroxene which, in some cases, is an aggregation of crystals and, in others, a fine grained rock resembling a finely crystalline limestone, but always much harder. There are many veins of what at first sight appears to be good asbestus ranging in width from an inch to three inches but, on close examination, these are found to lack the finely divided fibre and, being rocky, do not break into cotton but into coarse flakes rendering the veins of little or no value. The last pit towards the east contains a number of seams of excellent asbestus ranging from a half to an inch across and of much the same character as that of the western pit. The best quality of asbestus on the island occurs in a large boulder of light green, semi-translucent serpentine which is said to be found in place on the summit of Cuming mountain.

In order to arrive at some idea of these deposits of asbestus the writer, on his return home, paid a visit to Black lake and Thetford. The impressions and information gathered there lead to the conclusion that much of the asbestus of the Chibougamau region is almost identical with that found at Black Lake, with which it bears a close resemblance both as to length of fibre and number of veins. The veins shown in the openings and natural exposures appear to be closer together and of less width than in the best mines at Thetford.

Information gained at the working mines shows that a fairly good return is at present being made upon the capital invested, and upon the cost of mining and milling the asbestus. This profit is due to cheap labour, good mechanical processes in mining and milling, ready access to the railway and a short haul to Quebec or to the American markets. The difference between the cost of mining and milling a ton of serpentine and the selling price of the resultant asbestus is not very great so that a slight difference in the cost at which the asbestus can be placed on the market makes a considerable difference in the profits of the mine.

As at present situated, 205 miles from the end of the railway by the easiest route, the profitable mining of the Chibougamau asbestus is out of the question but, with a railway built to the shores of the lake and with a reasonable amount of capital, there is little doubt that several of the areas of asbestus-bearing serpentine, if worked economically, would yield good profits even against the added railway haul to market.

The present cost of transport by canoes or by winter hauling from Lake St. John to Chibougamau may be taken at fifteen cents a pound. With a road cut directly through the bush, winter haulage would pro-

bably reduce this price by one-half but even then it is doubtful if any active mining could be carried on at a profit in the best of the mineral deposits as yet found in the region. In the opinion of the writer all active work in the mines there must await the building of a railway to the shores of Chibougamau lake.